SCIENTIFIC AMERICAN

No. SUPPLEMENT. 352

Scientific American Supplement. Vol. XIV., No. 352. Scientific American. established 1845. NEW YORK, SEPTEMBER 30, 1882. Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

PNEUMATIC SEWAGE.—BERLIER'S PROCESS.

In measure as the population agglomerates in large cities, the question of disposing of the constantly accumulating night-soil assumes greater and greater importance. According to official documents, the excreta of the 2,300,000 inhabitants which form the fixed or floating population of Paris are increasing every day by 2,500,000 kilogrammes. The processes still in use, stationary and movable privy vaults, are as barbarous as they are unhealthy and repugnant. There has for a long time been a question of abandoning such systems, which are unworthy of modern times, and in view of the splendid results obtained at Gennevillers from the utilization of sewage waters for agriculture, the thought has occurred to make the sewers a receptacle for all residue without exception; the latter being led into them continuously along with sufficient water to dilute them properly.

The sewage waters, thus charged with the excrements of entire Paris, would be spread over the surface of vast tracts, and would go to fertilize the soil by giving up to it, through filtration and slow combustion, the organic matters that they contain. Such a method, however, has met with numerous adversaries among physicians, hygienists, and chemists; and a large number of savants and specialists have protested against the poisoning of the sewage waters, which, although they circulate in the subsoil of the streets, are none the less in contact with the external air through silt-basins and manholes, and would fill the atmosphere with mephitic gases and with dangerous microbes that they could not fail to carry to the soils that they went to fertilize.

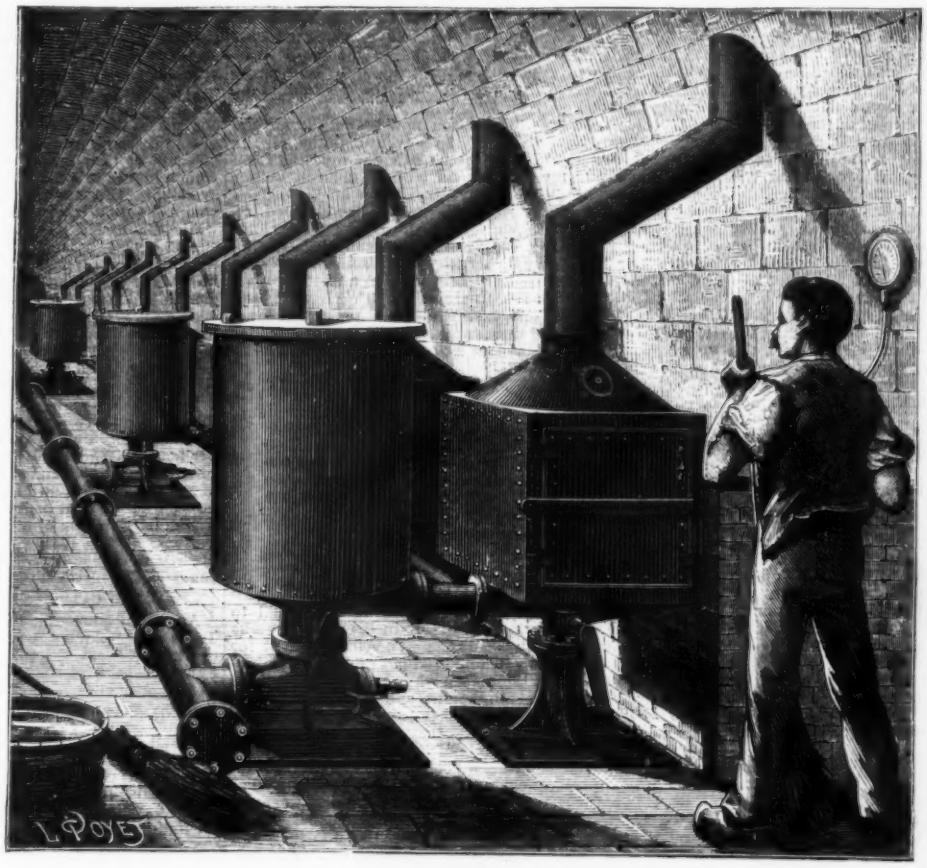


FIG. 1.—PNEUMATIC SEWAGE.—GENERAL VIEW OF RECEIVING APPARATUS.

In the midst of the discussions to which this question has given rise, an emeritus engineer, Mr. J. B. Berlier, has brought out a new system—one which is already in operation under most favorable conditions in Paris, and which permits of carrying night-soil to a distance in special piping without their ever coming in contact with the external air. This new method, which is called *pneumatic sewage*, appears to respond to all the requirements demanded by salubrity and hygiene.

We have visited the first installation of the system in Paris, and shall describe what we have seen.

Mr. Berlier has chosen for his experiments the Pépinière Barracks, which are constantly occupied by a thousand men. The privy vaults in this structure were generally in a bad state, and the cellars adjoining them were infected to such a point that the workmen therein dropped down asphyxiated. The air of the vicinity in hot weather was also often polluted with the emanations that were given off. At present, thanks to Mr. Berlier's process, the sewage of the barracks is being effected continuously, automatically, without the emanation of odors, and without obstruction.

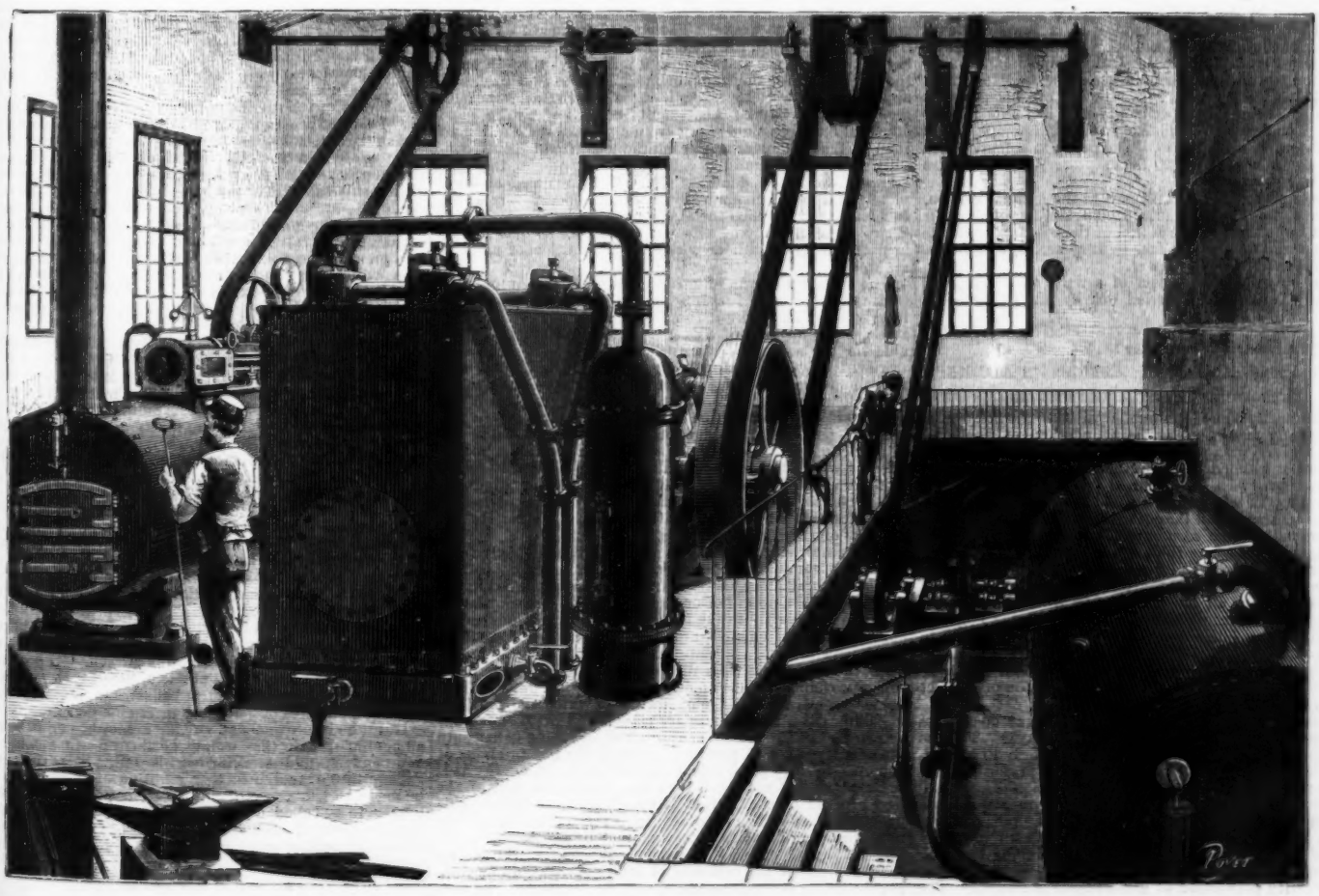


FIG. 2.—PNEUMATIC SEWAGE.—INTERIOR OF WORKS AT LEVALLOIS-PERRET, SHOWING THE ARRANGEMENT OF THE MACHINES.

Fig. 1 represents the Berlier apparatus installed under the water-closets of the Barracks, the excreta falling directly into the square receptacles seen to the right through the intermedium of a mechanism to be described further on. The matters are then carried by suction into a pipe running beneath the subsoil of the streets, and which terminates provisionally in the collecting sewer at Levallois-Perret, at several kilometers distant.

Fig. 2 represents the works at Levallois-Perret. Here, to the left, is seen the steam motor; in the middle the pneumatic pump; and, to the right, the large reservoir into which empty the products sucked into the system of piping. But before going any further into our general description, it will be indispensable to study a little more closely the mechanism employed by Mr. Berlier. We shall therefore examine successively: (1) the *receiving apparatus*, shown externally in Fig. 1; (2) the *system of piping;* and (3) the *hydropneumatic pump* that produces the vacuum.

The receiving apparatus of Fig. 1 are represented in section in Fig. 3. In the interior of the apparatus, which is placed under the chute, A, of the water-closet, there is a metallic basket, C, formed of wire, which allows the solid and liquid materials to pass, but holds back all foreign bodies that may have gotten into the pipe of the chute. The bottom of this basket rests on a pivot which, in turn, rests on a valve; and this pivot carries an angle pinion which engages with a conical wheel keyed on the axle. This latter, which is placed at the lower part of the receiver, traverses a tight packing designed to prevent any escape from the apparatus, and is made square at the extremity so that there may be adapted to it a winch for rotating the basket. At its upper part, the basket is guided and held by a rod which turns freely in the center. Through this arrangement, the basket may be rotated so much the quicker in proportion as the diameters of the toothed wheels are larger. The action of centrifugal force produces a settling of the materials contained in the basket, and the latter can then no longer retain any but those that are entirely indecomposable, and which, through their hardness, cannot be divided. Through this arrangement, and by actuating the basket from time to time (about every eight days), the number of inspections and removals of the basket is greatly diminished. The receiving apparatus communicates with a cylindrical vessel called the *evacuating apparatus*, which is shown in section to the left in Fig. 3. This apparatus is provided with a float, F, whose lower extremity, furnished with a rubber clock-valve, B, rests on the suction tube designed to carry away the matters. This part of the tube forms a cone into which is set the spherical rubber clock-valve, thus permitting of absolute tightness. When the materials reach the receiving apparatus they are emptied simultaneously into the evacuator; and, when there is enough of them to cause the float to act, the latter rises, opens the lower part, and allows them to be rapidly drawn into the piping, *b*, by reason of the difference of pressure existing between the external air and that in the interior of the pipe. The float then falls back and closes the clock-valve, and the materials continue to flow in without allowing the introduction of any air. This operation is renewed every time the level of the materials reaches the water line of the automatic apparatus. The receiving and evacuating apparatus are hermetically closed, and a person can go around the room containing them without any fear of being inconvenienced by bad odors.

The vacuum necessary for the operation does not exceed 15 centimeters of mercury, and it is obtained with great facility. Throughout the whole extent of the piping the solid matter is held in suspension in the liquid, as if an agitator were placed in the interior of the pipes. Such agitation, which resembles ebullition, is produced by the circulation of the internal air drawn up by the suction pump located at the works, and by the evaporation brought about in the mass of liquid by the diminution of pressure.

The pipes are of ordinary cast iron, and are connected with each other by rings, the joints being of lead.

Mr. Berlier succeeds in obtaining in a few minutes a vacuum of 70 centimeters of mercury by means of the system shown in Fig. 2. He employs a hydropneumatic pump whose piston works in water, and whose performance may be estimated at 90 per cent. The power of this pump is much too great for the experiments that are now in progress. The diameter of its piston is 60 centimeters, and it has a stroke of 60 centimeters. The pump is actuated by a movable steam engine of 20 horse power, and this also actuates the rotary pump.

This latter plays an important part in the general system. Placed near the reservoir into which the materials pour with great force through the action of the vacuum, it effects in its turn their removal as fast as they arrive, and forces them provisionally into the sewer.

Such is the *pneumatic* system of sewage as it has been scientifically studied and carried out by Mr. Berlier.—*La Nature.*

[Continued from SUPPLEMENT No. 351, page 5604.]

BRITISH ASSOCIATION.—PRESIDENT'S ADDRESS.

IMPROVEMENTS IN THE USE OF GAS.

GAS is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is moreover not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gas-works. In all cases where the town to be supplied is within, say, thirty miles of the colliery, the gasworks may with advantage be planted at the mouth, or still better at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would acquire an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil district is used in large quantities.

The quasi-monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during daytime to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of the electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute; and improved burners, rivaling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hoffman, regarding the coal-tar bases and the chemical constitution of indigo—the value of coal-tar in London was scarcely a halfpenny a gallon, and in country places gasmakers were glad to give it away. Up to that time the coal-tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal-tar naphtha mixed with toluene, cumene, etc. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal-tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the mean time, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of coloring matter.

The color industry utilizes even now practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthaline resulting from distillation of coal-tar; and the value of the coloring matter thus produced is estimated by Mr. Perkin at £3,350,000. The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gasworks. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia; which, taken at £20 10s. a ton, represents an annual value of £1,947,000.

The total annual value of the gasworks by-products may be estimated as follows:

Coloring matter	£3,350,000
Sulphate of ammonia	1,947,600
Pitch (325,000 tons)	365,000
Creosote (25 000,000 gallons)	208,000
Crude carbolic acid (1,000,000 gallons),	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 tons consumption in working the retorts) at 12s.	2,400,000
Total	£8,370,000

Taking the coal used, 9,000,000 tons, at 12s., equal to £5,400,000, it follows that the by-products exceed in value coal used by very nearly £3,000,000. In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favored with those semi-gaseous by-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound, resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh, last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapor; these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapor, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye-works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognized, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced, fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realized as completely and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two-thirds of its volume being nitrogen. The use of water-gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas carbonic oxide, the introduction of which into dwelling-houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion, 22,000 heat units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due, partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas-burners have shown that in this direction also there is much room for improvement. The amount of light given out by a gas-flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the one twenty-fifth part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2,300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gaslighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

UTILIZATION OF GASEOUS FUEL.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of a dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able, by this method, to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable. In the condensing steam-engine this waste heat comprises that communicated to the condensing water, while the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell.

Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel consumption not exceeding 1 lb. of coal per effective horse-power per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam-boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the early part of our century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

THE GAS-ENGINE FOR MARINE PURPOSES.

According to returns kindly furnished me by the Board of Trade and "Lloyd's Register of Shipping," the total value of the merchant shipping of the United Kingdom may be estimated at £126,000,000, of which £90,000,000 represent steamers having a net tonnage of 3,003,988 tons; and £36,000,000 sailing vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five-sevenths of our total imports and exports, or £500,000,000 of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind; comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus; the preparation of reliable charts for the guidance of the navigator, and the construction of harbors of refuge, lighthouses, beacons, bells, and buoys, for channel navigation. Yet notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during the last year as many as 1,007 British-owned ships were lost, of which fully two-thirds were wrecked upon our shores, representing a total value of nearly £10,000,000. Of these ships 870 were sailing vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing vessels included in these returns being 19,325, and of steamers 5,505, it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyages for one of the sailing ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favor of steam-shipping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing vessel per net carrying ton the proportion of 3:1, thus reducing the ratio in favor of steam shipping as 13·29 to 10·38, or in round numbers as 4:3.

In considering the question how the advantages thus established in favor of steam shipping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876-78, when they constructed at Pembroke dockyard the two steam corvettes, the Iris and Mercury, of mild steel. The peculiar qualities of this material are such as to have enabled shipbuilders to save 20 per cent. in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines with a strength 30 per cent. superior to that of iron such extreme toughness, that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any signs of rupture, a quality affecting the question of sea risk very favorably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulkheads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water ballast, but powerful pumps should in all cases be added to meet emergencies.

If to the improvements already achieved could be added an engine of half the weight of the present steam-engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent. could be made to the cargo of an Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favor of such vessels would be sufficient to restrict the use of sailing craft chiefly to the regattas of this and neighboring ports.

MARITIME IMPROVEMENTS.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in

the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and vice-president of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, it flora and fauna, as also the rainfall and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, while in this country the persistent labors of Dr. William Carpenter deserve the highest consideration. Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predicter, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson. The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighborhood of the binnacle; but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876, Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principles to be applied completely. Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one-quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained, not by the quantity of wire run over its counter and brake-wheel, but through the indications produced upon a simple pressure gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colorless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls

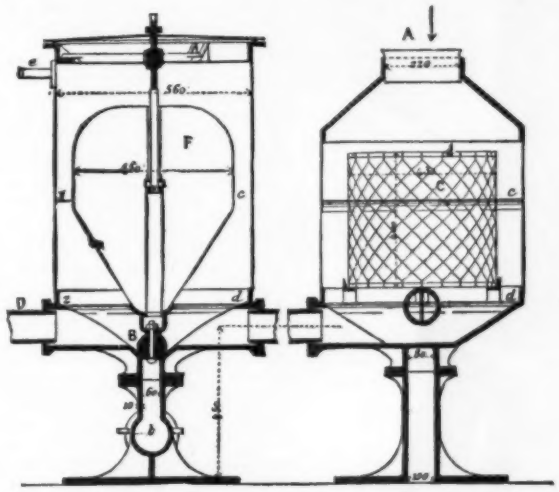


FIG. 3.—SECTIONS OF EVACUATING AND RECEIVING APPARATUS.

"soundings" can hardly be exaggerated; with the sounding-machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations, and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer, Mosel, not a fortnight ago, would not be possible. As regards the value of the deep-sea instrument, I can speak from personal experience, as on one occasion it enabled those in charge of the Cable S. S. Faraday to find the end of an Atlantic cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings in the supposed neighborhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable 20 miles away from the point where dead reckoning had placed the ruptured end.

MODERN ENGINEERING ENTERPRISES.

The great success, both technically and commercially, of the Suez Canal, has stimulated M. De Lesseps to undertake a similar work of even more gigantic proportions, namely, the piercing of the Isthmus of Panama by a ship canal, 40 miles long, 50 yards wide on the surface, and 20 yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is £20,000,000, and more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop M. De Lesseps in its speedy accomplishment. Through it, China, Japan, and the whole of the Pacific Ocean will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to over-estimate. Side by side with this gigantic work, Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship-railway to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of 95 miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler, have expressed a favorable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship-railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. De Lesseps will be successful also in careful inquiries. These inquiries have been made by a Royal scientific commission, and will be referred for further consideration to a mixed parliamentary committee, upon whose report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr. John Fowler of connecting England and France by means of a ferry boat capable of taking railway trains would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand 150 feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been entrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

IMPROVEMENTS OF EXPLOSIVES.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karolye (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air), the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminishes with the density of the charge.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge especially directed to the preservation of the gun's bore, have become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared to be *prima facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be, at any rate, in part due to its one component, sulphur, Noble and Abel have made comparative experiments with powders of usual composition, and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion vessel under high tension being carefully determined. With small charges, a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent.), was found equal to it under these conditions, and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Professor Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder. This powder has among others the peculiar property of completely resisting the action of water, so that the old caution, "Keep your powder dry," may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent leads us up to a consideration of the aggregate state of matter under other circumstances. As early as 1776 Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint glass, or only slowly as in crown glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of gutta percha an increase of electricity takes place.

PHENOMENA OF ELECTRICAL DISCHARGE.

Still greater strides are being made at the present time toward a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step, the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes were Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3,000 Leclanche cells, Dr. De La Rue, in conjunction with his friend, Dr. Hugo Muller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture, "On the Phenomena of Electric Discharge," delivered at the Royal Institution in January, 1881, he employed a battery of his invention, consisting of 14,400 cells (14,833 volts), which gave a current of 0·054 ampere, and produced a discharge at a distance of 0·71 inch between the terminals. During last year he increased the number of cells to 15,000 (15,450 volts), and increased the current to 0·4 ampere, or eight times that of the battery he used at the Royal Institution.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crookes' radiations) in traversing the tube.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge.

"5. That striæ are not merely loci in which electrical is

converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction coil excited in a new way—viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

SOLAR PHYSICS.

These investigations assume additional importance when we view them in connection with solar—I may even say stellar—physics, for evidence is augmenting in favor of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulæ, which have yielded spectroscopic photographs under the skillful management of Dr. Huggins, and Dr. Draper, of New York. Armed with greatly improved apparatus the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer, Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz.:

1. That aqueous vapor and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapors upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is, therefore, a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper) were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Professor Langley, of Pittsburg, has shown, by means of his Bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by his new photometric method that absorption due to hydrocarbons takes place somewhere between the solar and terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel, with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydrocarbon and aqueous vapor would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognize principles of high perfection, applicable also to comparatively humble purposes of human life. We shall thus find that in the great workshop of nature there are no lines of demarkation to be drawn between the most exalted speculation and commonplace practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through His works.

DEPREZ'S ELECTRIC POWER HAMMER.

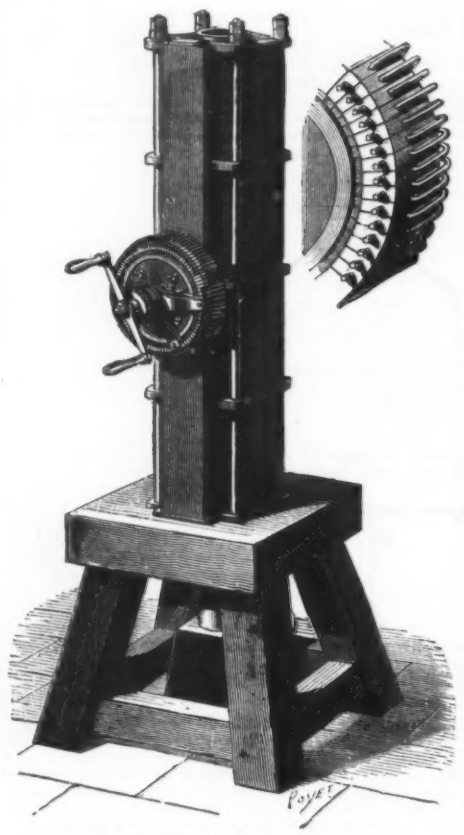
THE present tendency in a large number of modern shops is to do away with ordinary shafting, and replace it with a system of steam-pipes which bring the power directly to each tool. The power hammer is a type of this kind, and the interesting apparatus of Marcel Deprez shows that now electricity may render services which, up to the present time, have been almost exclusively reserved for steam.

The new electric power hammer, shown in the accompanying cut, must be considered as an experimental apparatus, constructed especially for the purpose of study. It was operated during a lecture by Mr. Deprez, at the Conservatoire des Arts et Métiers, in order to prove the elasticity of his system of distribution, and the variety of applications of which electricity is susceptible.

The apparatus consists of a solenoid, one meter in length, composed of a series of flat superposed bobbins, and forming a hollow cylinder in which moves freely a second cylinder of soft iron, weighing about 25 kilogrammes. The flat bobbins, eighty in number, are connected with each other in such a way that the outcoming wire of the first is united to the entering wire of the second, the outcoming wire of the second to the entering wire of the third, and so on. All these bobbin connections end in the keys of a circular commutator, whose functions we shall perceive further on. The system generally—bobbins and commutator—represents in principle a Gramme ring stretched out into a rectilinear form and connected with its circular collector. Over this latter there pass two brushes, which form between them an angle sufficient to embrace about ten keys of the commutator. These ten keys move together, and are maneuvered by means of a double hand-gear. Communications between the two brushes, and an external source of electricity of suitable power, are set up in such a way that the current shall enter through one of the brushes and leave through the other, after traversing the ten bobbins corresponding to the ten keys of the commutator interposed between the two brushes.

Let us suppose that at the beginning of the experiment the movable cylinder located within the solenoid is resting on the anvil, and that the current is traversing the ten lower bobbins; then the hammer (for thus we shall style the movable cylinder) will be raised to a certain height, so as to place itself in the region that is traversed by the current in a position that will depend upon the weight of the cylinder, intensity of the current, and the general conditions on which the system is constructed.

If we cause the commutator to revolve in a certain direction—from right to left, for example—the current will cease passing into 1, 2, 3, *n*, lower bobbins, and will pass into 1, 2, 3, *n*, bobbins above the tenth. By virtue of the action of solenoids on soft iron, the hammer will be lifted in such a way as to place itself at every instant in the region of the solenoid traversed by the current. An inverse movement of the commutator will produce an inverse effect—that is to say, a descent of the hammer. These motions of the hammer, and the blows produced by its fall, may be varied, the former in speed and the latter in power, by a proper maneuver of the brushes. There may be produced at will a sudden blow, or the hammer may be stopped near enough to the anvil to crack a nut without crushing it; in a word, there may be reproduced by this ingenious arrangement all those experiments that are to-day so familiar, and that are accomplished by the steam power hammer. By varying the number of the sections of the solenoid comprised between the two brushes of the commutator, the power of the hammer may be varied at will, and, after some experimentation, the apparatus may be put in better working conditions. With an intensity of 43 amperes, and 15 sections interposed between the brushes, the stress exerted on the cylinder reaches 70 kilogrammes, or about three times the weight of the hammer, while it is also maneuvered with greater facility.



NEW ELECTRIC POWER HAMMER.

In the experiments made at the Conservatoire des Arts et Métiers on the 15th of last June, the power was well shown in the fruitless efforts made by the assistants to force the hammer down while it was being held by the current at the upper end of its travel.

It goes without saying that the wooden frame at the base, which prevents access to the anvil, will be done away with in practice, and replaced by a cast-iron frame of suitable form.—*La Nature.*

THE MAGNETO-ELECTRIC GENERATOR OF M. DE ROMILLY.

THE magneto-electric machine of M. Worms de Romilly was patented in France, in March, 1866, and the specification under which the invention was secured is a very remarkable one, as it contains the first indication of much that has been done by subsequent inventors. The patent claims three classes of armatures, which are described and illustrated beneath in much detail—the ring armature, the drum armature, and a second form of ring armature, in which the wire is coiled upon a deep and narrow ring, so as to present a broad surface of coils to the fixed magnets, at right angles to the axis of rotation. Further, in the principal arrangement described, the field magnets—permanent, not electro-magnets, however—are arranged in a parallel series, and running longitudinally around the armature, and two such series of magnets are employed, one placed without and the other within the ring, so as to utilize both sides of the coils. The armatures described, suggest at once those, long afterward patented, of Gramme, of Alteneck, and of Schuckert, while the arrangement of the field magnets resembles not a little that of De Meritens and of Jablochkoff; again, the mode of utilizing the inner as well as the outer sides of the ring recalls the recent proposals of Jürgensen and others

The text of M. De Romilly's specification is as follows: When we cause a metallic plate to pass before the pole of a magnet, perpendicularly to the axis of this magnet, whether the movement is reciprocal, or whether, having the form of a disk, it revolves without interruption before the poles, there are set up in this plate induced currents, perpendicular to the direction of movement, and of the same sign, before and after the passage in front of the pole. This phenomenon, discovered by Arago, explained afterward by Faraday, and studied in their details by Poisson, by Nobili, Antisson, and Mateucci, have received the name of "magnetism of rotation," "or magnetism of movement." It is the collection and utilization of induced currents, which are produced when a metal plate passes before the pole of a magnet, perpendicular to its axis—currents which are set up perpendicular to the direction of the passage of the current—that is to say, the collection and utilization of those currents due to what is named "magnetism by movement," or "magnetism of rotation," which I propose to reserve by the present patent. Induced currents which, up to the present time, have been utilized by employing artificial or natural magnets, have always been produced by the successive reciprocations of a bar of soft iron carrying one or several wires coiled in a direction perpendicular to its axis, and passed in front of the inductor magnet in such a way as to be magnetized or demagnetized rapidly (as in the Clarke and Alliance machines), or have been produced by the passage, and the successive and rapid interruptions of a current from a voltaic battery in an inductor wire coiled round a bar of soft iron, and itself covered with a coil, in which is set up the induced current (as in induction coils or Ruhmkorff machines). Here it is necessary to pass before the pole of a magnet, or between the two poles of a magnet, a piece of metal of high conductivity—a plate or a copper wire, for example—and to collect the current thus obtained. Experiments made up to the present have been conducted with revolving disks, or with plates passing and repassing before the poles. The current thus produced is very weak, which has rendered it impossible to collect them so as to employ them as ordinary induced currents. What renders the current so feeble is, in the first place, the continuity of the plate or disk, which allows it to be dispersed with extreme facility, so that only a small part can be taken off to demonstrate its existence.

To obviate this inconvenience, it would suffice to pass before the pole a succession of wires, separated from each other, and each extremity of which would communicate with a fixed conductor that would come in contact successively at the moment of their passage before the pole. The current would thus be produced successively on the passage of each separate wire before the inductor pole, without any part being lost, as is the case with a continuous plate. This current, very feeble, when the wire passes before a single pole, is greatly increased when it passes between two opposite poles.

I now assume that it is possible to connect each of these separate wires to the adjacent wire in such a way that the current obtained in one may be in the same direction, and, as it were, a continuation of that which is obtained in the other; in this manner a kind of battery would be obtained, each wire of which would represent an element. To arrive at this, we cause to revolve between two poles of the same name—both north or both south—a plate of soft iron covered with well insulated wire, and coiled in such a manner that the flattened spirals in this iron core are presented perpendicularly to an imaginary line joining the two poles, and perpendicular also to the line indicating the direction of movement of the plate. The soft iron will thus assume a polarity contrary to that of two similar poles. The passage of the plate covered with wire will give rise, on the one side, to a current procured by the wire traveling before a north pole, for example, and a south pole is produced in the plate itself by the influence of the fixed pole, while on the opposite side of the plate there is set up in the coil of wire a contrary current produced by the passage in the same direction before a south pole, resulting from the influence on the soft iron plate, and the other fixed north pole. The semi-spirals on one face of the plate partake of the same movement as the semi-spirals of the other face in a contrary position, referred to a fixed pole, and the pole, produced by induction.

This is precisely what is required in order that the currents which have to flow around the core may form at each semi-coil, at each coil, and throughout the series of coils, a continuation of each other. If, then, we suppose a long plate of soft iron thus surrounded, and passing between the similar poles on the two extremities of the coil, being connected by a conductor to a galvanometer, this latter will indicate the presence of a continuous current as long as the plate moves in the same direction, but which will be interrupted when the movement is reversed, and which will take the contrary sign when the plate travels in the opposite direction. The sign of the current can also be changed, by the introversion of the poles, by the direction of the movement, and also by the direction of winding the coils to the right or left. Further, this wire coiled singly can be covered by a second wire wound parallel to it, and brought back over itself, so as to surround the soft iron core several times. Each thickness of the coil superposed will add its current to that of the preceding coil. In this manner, instead of a feeble current, we shall have one, the energy of which will depend on the power of the magnets, on their proximity, on the purity of the soft iron core, on the number of superposed coils, and upon the velocity of movement.

Now to consider an arrangement which will make this process practical, and by which one can collect the induction currents of which we have been speaking. Instead of a soft iron plate, we will take a plate curved in such a way as to form a cylinder, of which the diameter is much greater than the height. We will connect this cylinder by radial arms converging from one side to a rigid shaft passing through the center of the cylinder; this shaft will rest on bearings in which it may revolve rapidly. The cylinder, entirely open within, has thus only one of its sides partially occupied by the radial arms, that serve to fix it to the central shaft. This arrangement allows of winding longitudinally on the cylinder a copper wire covered with an insulating material. We will first assume only half the circumference of the cylinder to be thus covered, then we will place in close proximity to one side of the cylinder two magnets, each formed of a bar of steel magnetized; the similar poles of these two magnets—the north for example—are opposite to one another, and allow the iron cylinder, one half of which is surrounded with insulated wire, to pass between them; in this way the wire receives an opposite polarity. We will now do the same thing with the side of the cylinder diametrically opposite, in such a way that on this, as on the other, a magnet passes within the cylinder (and parallel to it), having its north pole in close proximity, while a second similarly magnetized bar is placed outside, in such a way that the

cylinder passes between two south poles. Now we will connect each end of the wire coiled on the half circumference to two terminals placed near the shaft, and insulated from each other; then we will connect, by a conductor, these two terminals with a galvanometer. Then, by means of a pulley, fast on the shaft of the apparatus, we will impart a movement of rotation to the cylinder. The coil successively revolves perpendicularly between the two poles, north on one side and south on the other. The soft iron core will assume a polarity contrary to that of the magnets, in the portion comprised between the poles, and subjected to their influence. From this there results, as in the plate to which reference has been made, similar currents, so long as the half circumference on which the wire is coiled passes between two poles of the same name; but so soon as it passes between magnets of the opposite polarity, the current will change its sign. Thus one half turn will give a current of one sign, and the complimentary half turn will give a current of the opposite sign. If we continue the coiling around the cylinder in the same direction—to the right, for example—in such a way as to surround the whole cylinder, we shall not perceive any current, since, while half the circumference passed before one pole, the other half circumference would pass before the opposite pole, giving a current the inverse of the former. To avoid this, it is necessary to utilize the effect of the two poles, which is easily done by coiling the wire of one half circumference in a direction contrary to that of the other half. Thus, if the former be coiled to the right, the latter must be coiled to the left; in this manner, the effects of the pole being reversed with each half revolution, at the moment when the half circumference to the right passes between the north poles, the other half, coiled to the left, passes between the south poles, and they will give simultaneously a current of the same sign, the opposite directions of winding serving to destroy the opposition of the poles. The first half circumference having passed before the north poles, will present itself before the south poles, passing between them, while the second half-circumference passes before the north poles. The current in the first half circumference will change its sign in passing before the south poles, at the same time that a similar change will be effected for the second half circumference before the north poles. At each half revolution the current in the two semi-circumferences with the wire coiled in opposite directions will change its signs simultaneously. Thus for each revolution there will be two opposite currents which will follow one after the other through the whole of the wire coiled around the soft iron core. If, instead of simple insulated terminals, we place a commutator on the shaft of the cylinder, we shall perceive currents always in the same direction, and which will produce the effect of continuous currents.

In place of a single coil of wires, several thicknesses of wire may be superposed, and instead of a pair of magnets on each side we may place several pairs in such a way as to surround a half circumference inside and outside with similar poles, and the whole of the other half circumference within and without with poles of an opposite sign. (See Figs. 1 and 2.) Collectively these series of magnets form two concentric cylinders between one end of which the soft iron ring covered with its coils revolves. The electromotive force of the current increases within the number and length of coils, with the speed of rotation, and the number and power of the magnets. Each complete turn or half turn of wire is attached by the two ends to a brass terminal placed on a wooden bar, and fastened to the radial arms of the cylinder. With these terminals we connect the various superposed wires, either in such a way as to form only one large cable, or end to end, so as to be able to vary at will the electromotive force of the apparatus.

But it must be clearly understood that such an apparatus is only one of a thousand possible arrangements that may be indefinitely varied, and by which the principal protected by this patent may be put in practice.

For example, the soft iron ring may be given the form of a torus flattened perpendicularly to the axis of rotation, and having its wire coiled radially, so as to form a sort of disk pierced with a large central hole, in order to allow the radial coiling of the wire, the ring being mounted rigidly on a shaft passing through its axis. Magnets would be placed radially around the disk on each side, with similar poles opposite each other, as in Fig. 3.

Or, the soft iron core may be formed as a cylinder with flat parallel ends, having a steel shaft running through its axis, and fixed to it either by means of radial arms or by blocks of wood driven into the cylinder at intervals; this shaft rests in bearings, and a pulley is arranged to drive it; this cylinder is surrounded parallel to its axis with an insulated copper wire, following always the same direction and passing from one side to the other by a turn diametrically across the ends of the cylinder. On the first coil thus made is superposed (always winding in the same direction) a second turn, and in this way are joined several coils in succession, and the ends of the wire are connected to a galvanometer. Diametrically on each side of the cylinder, I place magnets, each having their opposite pole turned toward the cylinder. The magnet on one side turns its north pole, while opposite, the magnet on the other side turns its south pole to the cylinder. These magnets may each of them extend over one-half the surface of the cylinder. If now we cause this cylinder to revolve, we shall set up, at each half-turn, a current of an opposite direction, but simultaneously of the same sign in the coils. An analysis of the manner in which each element of the wire is presented to the poles, is too similar to the preceding explanation to require repetition; a commutator placed on the axis of the apparatus allows the currents to be collected so as to be practically continuous. Each turn and each half-turn on the cylinder can be made by a separate wire, the two ends of which, each going to a terminal, can be joined to the other wires in such a way as to give to the current the required electromotive force. Practically the envelopment of the cylinder cannot be effected by wires placed one after the other, and coming in succession across the diameter of the two bases. It is necessary that they should clear the shaft, and then, superposed on each other, they would form around the shaft a thickness equal to the sum of the collective thickness of wire in all the coils. This thickness would be doubled with the second coil of wire, tripled with the third, and so on. To avoid this inconvenience, the circular bases of the cylinder are divided into six or eight equal parts, and the wires are wound in such a way as to form in each division a parallel band like a ribbon, along each side of the cylinder, and passing diametrically across the ends. These bands would be necessarily opened in the middle to make room for the shaft, and then brought together again. Each band of parallel wires is laid close to the succeeding one upon the cylinder, and they are superposed on each other in passing across the ends, so that the entire surface of the cylinder will thus be covered, as shown in Fig. 4. In this way we shall have at each end a height of superposed wires which will only be the sum of the thickness of one wire multiplied by the number of superposed bands.—*Engineering.*

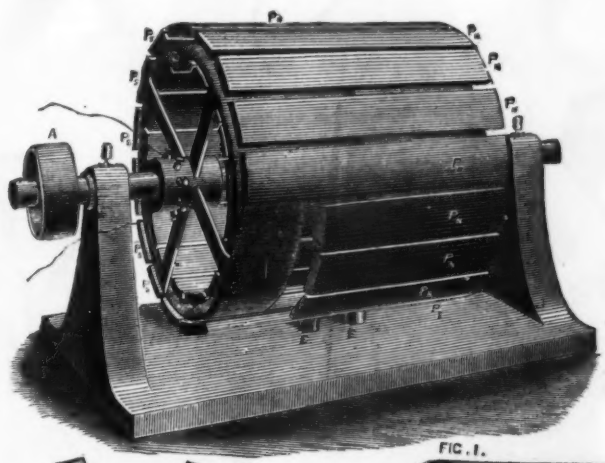
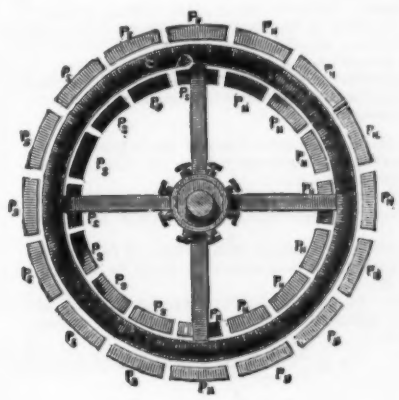


FIG. 1.



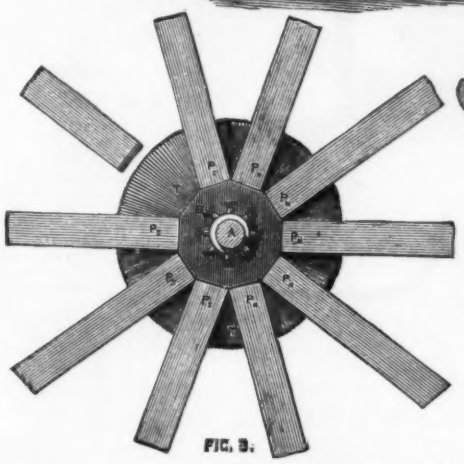


FIG. 3.

FIG. 4.

DE ROMILLY'S MAGNETO-ELECTRIC MACHINE OF 1866.

CHEMICAL WORK PRODUCED BY THE BATTERY.—It results from Tommasi's experiments that a chromic acid element, as employed by Favre, that is to say, having a positive electrode of platinum, produces an external chemical work only equal to about 65 cals. If in the same element we substitute for platinum, carbon or platinum sponge, about 85 cals. may be rendered transmissible to the circuit, or 20 cals. more than in the former element.

ELECTRICITY IN DYEING AND PRINTING.

By M. F. GOPPELSROEDER.

SINCE his former communications on the electrolytic formation of coloring matters the author has obtained further results.

1. To produce aniline-black upon cloth or paper he saturates them with an aqueous solution of a salt of aniline, preferably the hydrochlorate. He places them upon a plate of metal not capable of being attacked by the solution, and in contact with one of the poles of a galvanic battery or a small dynamo electric machine. He places upon the cloth or paper a second metallic plate, which bears in relief the design to be produced, and which is in contact with the other pole. On giving the necessary pressure and causing the current to pass, a copy of the design is obtained in black. He has also in this manner reproduced medals and coins. Further, it is easy to write with a pencil of a metal which is not attacked or of conductive carbon, forming one of the poles, upon the tissue or paper saturated with the solution of aniline salt, and laid upon a metal plate which forms the other pole. Wherever the pencil, lightly pressed, touches the material the current passes, and there is a development of black, which is fixed upon the fiber with the same solidity as blacks produced by the ordinary methods. This method may be employed in manufacturing establishments for making pieces with a solid color, black or otherwise, capable of resisting the operations of bleaching, dyeing, and printing. The author has confined himself to speak of the formation and simultaneous fixation of aniline black, but his method applies to every other coloring-matter capable of being as readily formed by oxidation or dehydrogenation, and of being fixed upon tissues.

2. The same method of operation may serve for the discharge of colors fixed upon cloth, *e. g.*, Turkey-red or indigo-blue. The dyed pieces are saturated with a solution of nitrates, such as saltpeter, or chlorides, such as sodium and aluminum chlorides. At the positive pole there is produced nitric acid or chlorine, which attacks the color, changing it into colorless oxidation products, so that the parts of the cloth in contact with the relief of the second plate becomes decolorized. We obtain thus a white discharge on a red, blue, etc., ground. By selecting salts whose bases may play the part of mordants, we may thus, by a dye-bath, produce new colors at the discharged parts. It is also possible that certain oxides set free by the action of the current, of the higher oxides and colors formed by the same action, may fix themselves upon the cloth and impart to it their color. The author hopes soon to make known the reactions of the various salts in presence of the fibers under the influence of the current, as well as of the colors and mordants to which they may give rise. But there is still another manner of discharging, forming, and fixing colors simultaneously. If we saturate tissues (Turkey-red or indigo blue) with aniline hydrochlorate, there will be, on passing the current, not merely discharge of the color, but at the same time formation of aniline-black.

3. There are also cases where the negative electrode plays the principal part. The oxidation of colors during printing may be prevented by plunging the negative electrode of a battery or of a small dynamo-electric machine into the color-trough which contains the color to be printed on, and placing the contents of this principal trough in communication with a very small secondary trough, which contains either the same color or any liquid conductor, into which is plunged the positive electrode. The communication is made either by a septum of parchment paper, or of porous clay, or by a tube. The hydrogen is evolved at the negative pole in the midst of the color to be printed, and hinders oxidation. It is possible to precipitate upon the fibers heavy or precious metals. It is merely necessary to impregnate the cloth with a solution, properly thickened, of a salt of

any of these metals, and to let the negative electrode act in order to precipitate the metal upon the fiber.

4. The current may also be used for preparing vats of indigo, aniline-black, etc., utilizing the hydrogen which is liberated at the negative pole. The color is thus reduced as effectually as by the ordinary methods. When such vats are prepared their oxidation may be prevented by causing the negative electrode of a feeble continuous current to act upon them. A separation, as perfect as possible, of the two electrodes is required, which will not present any difficulties.—*Comptes Rendus.*

THE ELECTRICAL RESISTANCE OF GLASS AT LOW TEMPERATURES.

M. G. FOUSSEREAU.

THE method of determination consists in causing the current from a battery of from 1 to 100 voltaic elements to pass through a test tube of from 0·01 m. to 0·002 m. in diameter, and of uniform thickness.

The current is collected in a condenser of known capacity, the two poles of which are connected with the mercurial standards of a Lippman electrometer, also of predetermined capacity.

The time necessary to communicate to the mercurial column of the electrometer a displacement corresponding to a predetermined difference of potential is noted.

The test tube is placed in a beaker, or glass, while its two surfaces are moistened by being immersed in and containing up to a known height concentrated sulphuric acid, which constitutes the conducting medium. Platinum wires are immersed in the sulphuric acid, care being taken that they do not touch the sides of the glasses.

This apparatus is placed under a bell glass; the contained air becomes dried by contact with the sulphuric acid before the commencement of the experiment.

In order to obtain a uniform and slightly varying temperature the lower portion of the apparatus is immersed in an oil bath up to a point slightly above the level of the acid. The oil bath is placed upon a sand bath, or an arrangement containing a frigorific mixture may be substituted for the sand bath. Experiments have been thus made at a temperature of —17° Centigrade:

Placing E as the electromotive force of the battery;
ρ^1 ρ^2 as the internal and external radii of the tube;
h as the height of the acid;
r as the specific resistance of glass per cubic centimeter;
C as the sum of the capacities of electrometer and condenser;
e as the difference of potential communicated to electrometer which value is always very small in comparison with E:
We then have as an expression from the quantity of electricity sufficient to charge the condenser during the time t,

$$r = \frac{2 \pi h E}{C e \log \frac{\rho^2}{\rho^1}} \times t$$

Many experiments made with different depths of acid allow of the elimination of error due to the influence of the bottom of the tube, which is of different thickness from that of the sides.

At the moment when the circuit is closed the glass tube is charged similar to a condenser. Its interior surface then absorbs little by little a certain portion of the electric charge, sufficient to bring it to a definite state corresponding to the amount of the potential established between the surfaces.

During this variable state, which is more or less prolonged, according to the nature of the glass, the effects of the charge are added to that due to the conductibility. Observations should be commenced when the charge in the electrometer becomes of constant value.

It has been also observed that a rapid heating increases the conductibility much more than is normal, and a corresponding lowering of temperature gives rise to an exaggerated resistance. These phenomena disappear rapidly, giving place to the normal resistance, and they are not produced when the variation of temperature is gradual.

Observations have been made up to the present time with three varieties of glass: ordinary glass, of a soda and lime base, Bohemian glass, and crystal. In these three cases an elevation of temperature produces a rapid increment in conductibility.

The resistance may be expressed by experimental functions as follows:

$$Log\ x = a - bt + ct^2.$$

1st. For ordinary glass of a density of 2·539, by expressing the resistance in millions of megohms per cubic centimeter, the following results were obtained:

Temperature.	Resistance.
+ 61·2° centigrade.	0·705
+ 20° "	91·0
— 17° "	7970·0

In order to arrive at a clear idea of the magnitude of this last resistance, it may be stated to be nearly twice that of a copper wire having a section of 1 c. mm., and reaching from the earth to the star Sirius.

The summary of the results obtained with ordinary glass is expressed as follows:

$$Log\ x = 3·00507 - 0·052664 \times t + 0·00000373 \times t^2.$$

The terms of the second degree being very small, the values of the *log x* may be graphically represented by a line differing but slightly from a straight one; the resistance varying about one-ninth of its value for each degree centigrade.

2d. Bohemian glass, with a density of 2·431, is from 10 to 15 times as good a conductor as ordinary glass at a corresponding temperature.

Its resistance is expressed by the formula

$$Log\ x = 1·78300 - 0·049530 \times t + 0·0000711 \times t^2.$$

3d. The crystal employed had a density of 2·933, and was found to be from 1,000 to 1,500 times a better insulator than common glass at a corresponding temperature.

Its conductibility did not become manifest until about 40° Centigrade.

At 46° Centigrade its resistance was 6183·0, and at 105° Centigrade it was 11·6.

These results are expressed by the formula,

$$Log\ x = 7·23870 - 0·068014 \times t + 0·00028073 \times t^2.$$

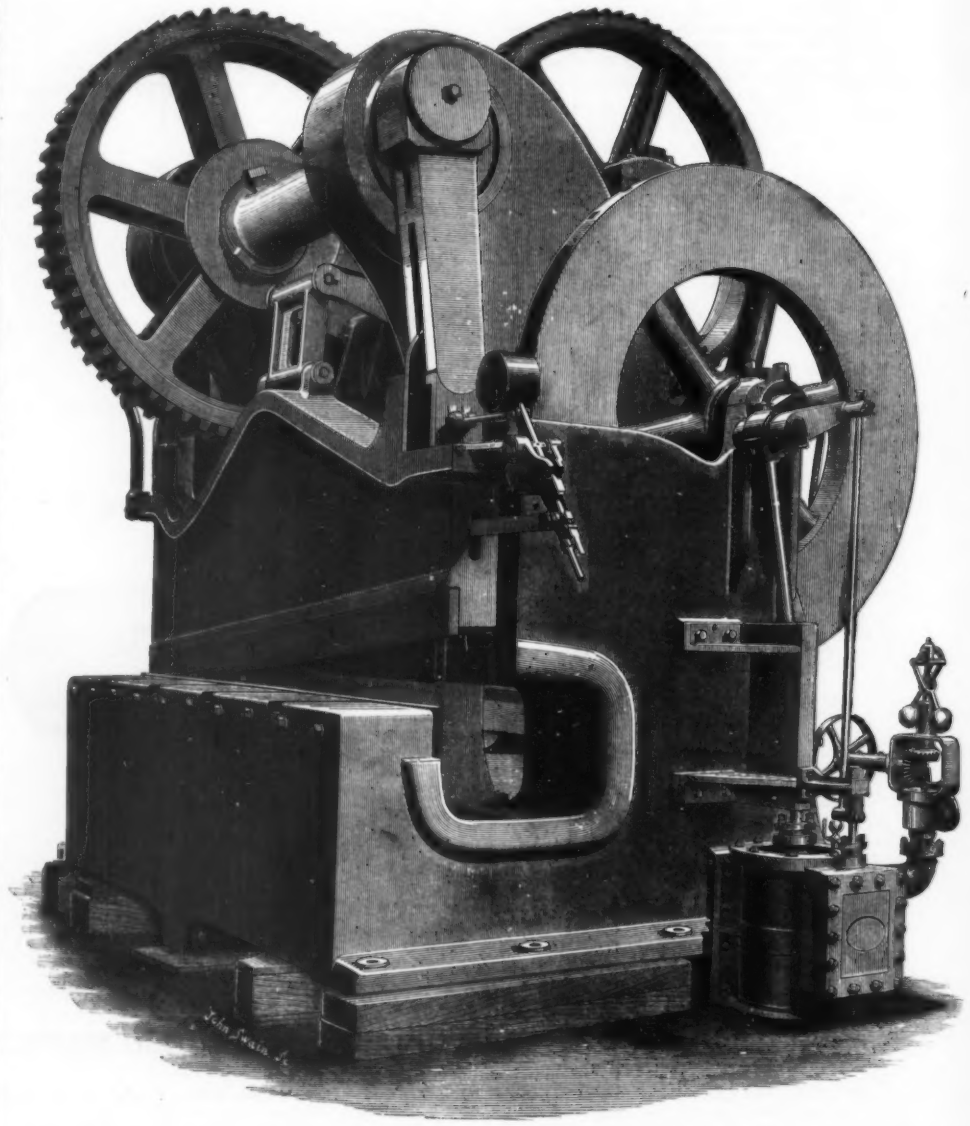
—*Comptes Rendus, July* 31, 1882.

THE BINKO ELECTRIC RAILWAY.

THIS system, which is now being worked in the grounds of the Crystal Palace, London, is thus described by Mr. W. Grist, in a recently issued pamphlet: "An eight horse-power engine by Messrs. R. Hornby & Sons is employed in working the primary dynamo, which is stationary, and which generates the current. Only about four horse-power of the engine is used for the requirements of the railway, and this power would be sufficient to work a line of three miles. The current generated by this dynamo is transmitted by underground cables to the two rails—one for the leading, the other for the return current. From the rails the current passes to the insulated wheels of the locomotive *and of the cars thereto attached, which are all electrically connected with the dynamo locomotive.* We have italicized here, as herein lies an important specialty of the Binko Railway. The current thus led to the dynamo causes its armature to rotate as explained above, and the motion thus obtained is easily, by the skill of the mechanical engineer, applied to traction purposes, over rails insulated as below explained. The length of the experimental railway is 350 yards; its gauge is, roughly speaking, about twenty inches; and the speed attained is from eighteen to twenty miles an hour. The weight of the engine is two tons, and of the cars half a ton each, each car being constructed to carry ten passengers. The first locomotive of the International Electric Railway Company has been named 'Volta,' the second, now in hand, is called 'Ohm,' both names being intended to commemorate two illustrious pioneers in electric science. We have mentioned the 'Blücher' and 'The Rocket' as the prototypes of a long line of steam locomotives; and it is not too much to suppose that fifty or one hundred years hence 'Volta' and 'Ohm' will enjoy a similar celebrity as the illustrious ancestors of many thousands of electric locomotives. The station and offices are lighted by incandescent lamps, the engine which works the electric locomotive being also used for this purpose; and arrangements are being made for lighting the train from the same current as for the railway. All signaling work in the station and offices is performed by electricity, the current, where not dynamo-produced, being generated from Binko's new patent galvanic battery. Even the letter-box is arranged to signal the fact that a letter or note has been deposited therein, the postman's knock being thus obviated. Having stated the main features of the working of the Binko Electric Railway, we may briefly call attention to the main points in which it differs from, and, as the patentee claims, improves on its predecessors. First of the advantages claimed is electric connection of the cars with the locomotive and with the rails. Instead of the cars being so much dead weight dragged by the locomotive, they 'pick up,' so to speak, current-energy by their contact with the rail, and supply their quota of strength to the whole. We before claimed as a specialty of the electric railway that it was fed by its own path; but in the case of the Binko Electric Railway we may go a step further, and say that the very journey augments its strength—'*vires acquirit eundo.*' A second advantage is the regulation of speed at starting. A sudden access of full current to a stationary electric locomotive is liable to produce an effect analogous to that of a sudden kick on the unsuspecting human frame. The initial velocity is not maintained, and injury to the mechanism frequently results. The Binko patent locomotive provides against this by a regulator consisting of a sevenfold switch, by which the current can be imparted in strengths varying from one-seventh to the full power. A third point is the regulation of speed during the journey. This is effected by means of a system of resistances under the control of the driver. The fourth point is that a perfect system of insulation prevents leakage, and obviates the need for the sectional system before alluded to. This is attained by laying in the chairs supporting the rails a bedding of insulite or other equally effective medium, or by insulating the rails from the sleepers by means of India-rubber, ebonite, or other insulating substance, whereby even the spikes do not come in contact with the rails. Owing to this precaution, rainy weather does not affect the practical working of the railway."

LARGE SHEARING MACHINE.

WE give an illustration of a very large shearing machine by Buckton & Co. The machine illustrated will cut steel or iron plates cold up to 1¼ in. thick 26 in. from the edge; it has 11 ft. face of knife, and a plate 8 ft. wide will go clear through the machine; such a plate the machine will cut right across at any part of its length at a single stroke. The moving shear-slide is balanced with a counterweight and fitted with a stop motion, so that while the engine, fly-wheel, and gearing may run continuously, the action of the shear can be stopped until the plate is put into position, when the two stop-blocks are slid by a coupled motion simultaneously into their places, and the slide is pressed down by a parallel motion, being acted upon at its two extremities by connecting rods driven by parallel eccentric pins on the two ends of the main shaft. All the wheels in this machine are cast with split bosses, planed at the joints and hooped with wrought iron rings. There are two overhung wheels about the machine; they each work between a pair of brass bearings, in which any wear that takes place does not prevent the teeth from still bedding fairly across the faces. The main eccentric shaft is of wrought iron 20 in. diameter, and works in solid brass bushes each 18 in. long. At each stroke of this machine it overcomes a resistance in the plate of about 4,000 tons of breaking load. The whole machine, with engine complete, is so self-contained that steam has been put into the cylinder at the makers' works, just as it stands depicted, on the floor, and a plate of the maximum dimensions cut into slabs with repeated strokes of the machine.



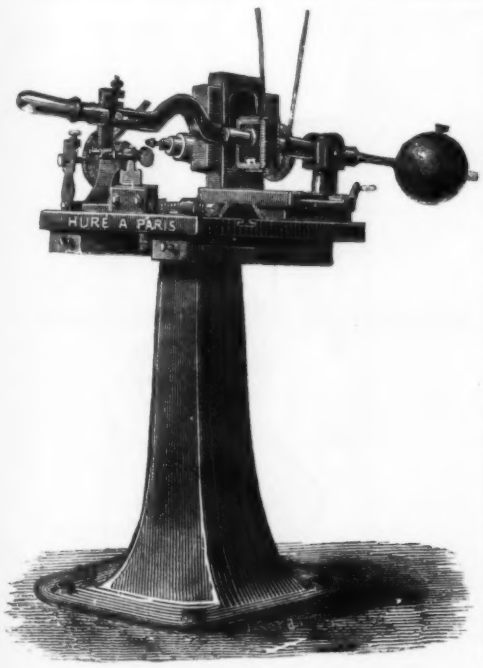
ELEVEN-FOOT SHEARING MACHINE, BY BUCKTON & CO., LEEDS.

At present there is a machine of similar design, but for plates 1¼ in. thick, in course of construction, at these works, and a machine of the size described is at work at the Bowling Iron Company's works, near Bradford.—*The Engineer.*

MACHINE FOR REPRODUCING, CUTTING, AND ADJUSTING COUNTERSINKS.

THIS machine consists of a cast-iron base surmounted by a rectangular table which supports the entire mechanism. The latter consists of a horizontal steel countersink-carrier shaft, on which is keyed a channeled pulley moved directly by means of a cord through a gearing placed above. This shaft is mounted on a carriage that is moved by means of a double-jointed lever which permits of the countersink being displaced vertically and horizontally. The horizontal carriage is mounted on a third transverse carriage provided with a screw and winch, by means of which the position of the cutting countersink is regulated with respect to the piece to be cut. The maneuvering lever is articulated with a pinion working in a revolving bearing placed on the transverse carriage. On the vertical carriage there is fixed a square box in which is adjusted a spherical piece belonging to the lever, and forming thus a swivel joint. Upon the lever, near the handle, there is mounted a sort of style which follows all the contours of a templet having the special form of the piece to be shaped, and which is three times the size of the latter, so as to insure of great accuracy. This templet is held between the chaps of a vise which is mounted on an adjusting screw carriage. The chaps of the vise are curved, and have the form of an arc of a circle whose center is situated on the axis of the revolving bearing in which the lever is articulated. When the sheet of iron representing the templet is fastened in the vise, it curves, and the lever style, which itself describes an arc of a circle, follows the contours of the templet from one extremity to the other. The piece to be cut is mounted on a puppet with dividing free plate, and which is provided with an alidade and adjusting screw. By means of the plate, the circumference of the piece is divided into as many parts as necessary.

When it is desired to reproduce any piece whatever with this machine, the piece is mounted on the puppet, and a small sheet of iron is fastened between the chaps of the vise. After this, the countersink of the countersink-carrier shaft is replaced by a small steel rod, and a spring style is



MACHINE FOR CUTTING COUNTERSINKS.

affixed to the lever in place of the other style. By maneuvering the lever so as to follow, by means of the steel rod, the contours of the piece to be imitated, the spring style reproduces on the sheet of iron an enlarged profile of such piece, after the manner of a pantograph. The templet is cut according to the lines traced, and it is then used as has been previously indicated. Under the machine are two drawers for holding the tools, templets, and exchange countersinks. The machine is arranged for reproducing, cutting, and setting countersinks of all forms, from those of 5 mm. up to those of 125 mm. in diameter. It also cuts gearings, and serves for adjusting and rectifying, through a small emery wheel, tempered countersinks. This apparatus is the invention of Mr. P. Huré, of Paris.—*Annales Industrielles.*

A MODEL MILL IN GERMANY.

IT has often been remarked by travelers on the Continent that the outward appearance of cotton and other textile mills is better than that of many similar establishments in England, the reason for which is generally not far to seek, as most of these mills are of modern erection, and have consequently had the advantage of the experience of our own millowners and architects. Besides, a new building always looks fresher in a bright than in a damp and smoky atmosphere. That we now have handsome mills of every kind in this country no one will deny who takes the trouble to look for them. But while travelers report about the outside appearance they generally know nothing about the inside. From what we have seen on the Continent we can affirm that generally the inside cleanliness corresponds with the appearance of the outside; but very often the superiority over similar mills with us ceases after pronouncing the word cleanliness. Order, regularity, quietness, and promptitude, cannot be found abroad as in our best establishments at home. There are, of course, exceptions, but we are speaking of the average. Under these circumstances it is gratifying to come across some model mills, of which there are here and there a few. We will select one near the Rhine, to show our readers what can be accomplished by an intelligent millowner who has the well-being of his hands at heart.

The mill in question contains 12,000 throstle and 370 doubling spindles, and employs 200 hands, of whom two-thirds are females, but only five or six are married women, and 30 children. The time made during the week is 65½ hours, including cleaning-time on Saturdays, the hours being from 6 in summer and 6:30 in winter to 6:45 in summer and 7:45 in winter, the dinner-hour being from 11:50 to 1:15. On Saturdays, the machinery is stopped at three o'clock, and the cleaning done until four; in winter, this is done half an hour later. Young people have half an hour's rest in the morning, so that they only work 60 hours.

The mill is built fire-proof throughout; the floors are laid with flags and tiles; all doors and windows are of wrought iron; the pillars are cast iron; all roofs are fireproof and carry water cisterns, with the exception of the engine roof; and all stairs are of stone and contained in separate fireproof wells.

The heating is done throughout by wrought-iron steam-pipes; in each room there is a thermometer with a plainly visible scale, and it is the duty of the overlooker to see that the temperature does not rise above 68° or 70° nor fall below 65°; the watchman has likewise to see that at the commencement of the work in the morning the temperature stands at 65°.

The lighting is done by gas, and all burners are provided with regulators, so that no unconsumed gas can escape into the rooms.

Each window has on its upper portion a part of about one square yard area, which swivels, and can be opened or shut from below so as to insure thorough ventilation without draught. There is also ventilation through the iron pillars, and ventilating shafts are inserted in the walls.

On the top landing of the stairs there is a cistern in which in the morning and in the afternoon water is boiled by steam, and which is carried by pipes into all the rooms, where the latter are provided with from two to four taps, so that the hands can draw hot water for making coffee. All rooms also contain water-pipes and plugs, and provision for washing hands.

There is a dining room for those hands who live too far away to go home to dinner, and here the young people have also their half hour's rest.

There is a reading room at the service of all employed in the mill, out of working hours, free of charge, and a library, for the use of which a trifling charge is made. The books which are least read are history, natural history, politics, and biographies; the boys read as much again as the girls, and both together one-third more than men and women together.

A novel feature is a fireproof bathing house, containing two rooms, in which hot, cold, and shower baths are arranged, and hot pipes for warming towels and the clothes. All hands may use these baths during the time between 8 A.M. and 7 at night, and must give notice beforehand to the foreman of their intention, who then assigns to each his time, allowing about half an hour for a bath, and arranging the allotment in such a way that at one time only men, and at another time of the day only women may bathe. All bathing is done during working hours (!) Each person has to pay one penny for a bath, for which also soap and towels are furnished. These baths are patronized principally in summer only, as many as 20 persons using them in a day; but at any time the women resort to them only sparingly.

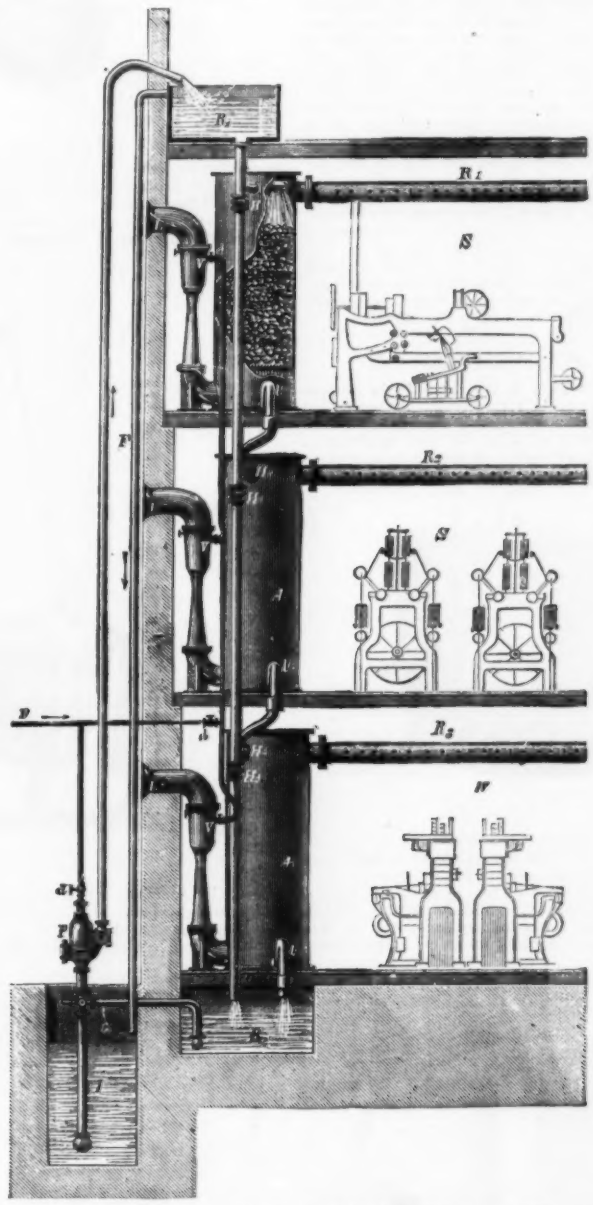
There is a savings bank and sick fund connected with the mill, both being managed by the firm. The contributions to the sick fund, which is compulsory, was last year $1\frac{7}{16}$ per cent. of the wages, to which the firm added 50 per cent. In the course of years this fund has accumulated money for which the firm pays 5 per cent. interest, and in order to prevent its getting unnecessarily large, the contributions have this year been lowered to $1\frac{1}{4}$ per cent. of the wages.

The contributions to the savings bank are not very numerous, though the firm allows 5 per cent. interest, the members being at the end of last year only nine, with a capital of £260. There is, however, an insurance office in the town with an endowed fund, for insuring payment in advanced age (commencing with 55 years), to which the hands of the mill contribute more liberally, while the firm have privately set aside a certain amount for aged hands of the female sex.

APPARATUS FOR MOISTENING AIR—KOERTING'S SYSTEM.

IN spinning and weaving rooms the surrounding air must be kept at a uniform and pretty high degree of moisture, the quality and quantity of work being dependent upon it. If we content ourselves with moistening the air by means of a jet of steam blown into the rooms, we solve the problem only in an imperfect way. It is indispensable, especially in summer, to combine the injection of steam with air sucked in from outside, and afterward to cool the mixture. It is only under such conditions that may be obtained an atmosphere suited to the work, and a normal temperature in workrooms devoted to the textile industry. The annexed figure shows the arrangement adopted by Mr. Koerting, in the installation of a cooling apparatus in each room of the different stories of a manufactory. In principle the new apparatus permitting of moistening air to the proper degree is as follows: A steam-jet ventilator on the Koerting system sucks in cold air from outside, and this air passes afterward through a metallic column filled with pumice stone or coarse coke, and from thence is forced into the spinning rooms.

By means of this method the air mixes intimately with the steam which serves for operating the apparatus, and which transmits a higher temperature to the air while rendering it moist. By its passage through the pumice stone, the water of condensation is kept in the apparatus, so that on its exit from the latter the air is saturated with moisture and contains no water in excess. A rose-head fixed to the



APPARATUS FOR MOISTENING AIR.

top of the column of pumice stone permits of an injection of cold water which removes the heat that is communicated to the air by the steam.

The Koerting apparatus is mounted in the room in a spot where it does not interfere with the operation of the machines. The suction mouth of the ventilators, V, communicates with the outside air through the intermedium of a wooden or zinc pipe, L; and a similar elbow connects the aspirator with the coke column, whose internal arrangement is rendered visible in the cut by the removal of a portion of the jacket of the upper cylinder.

Outside the building there is represented, as an example, the reservoir of feed water, C, surmounted by a direct acting steam pump, P, which receives the motive agent through tubing provided with a cock, *d*. The steam-pipe enters the factory, and takes a vertical direction in order to supply the aspirators, V.

The pump chamber is connected laterally with an elevating column, E, and, at its lower part, supports the suction-tube, I, which terminates in a rose and a branch with a two-way cock, whose vertical flange carries a pipe that ends in the well, B_3. The column, E, empties the water sucker up by the pump into the reservoir, B, which is provided with an overflow pipe debouching in G. From the bottom of this reservoir starts the pipe, H, into which is introduced the water that is designed to moisten the layers of pumice stone, and the excess of which escapes through the siphons, U. By following the directions of the arrows, the reader will easily understand the motion of the steam, water, and air in the different apparatus that go to form the complete system.

In order to obtain a proper distribution of the air cooled in this way, the cylinder, A, communicates at its upper part with a pipe, R, of the same diameter as L, and which is fixed to the ceiling of the spinning rooms. This pipe contains along its sides a large number of little holes, whose total section should be three times greater than that of the pipe, R, which is slightly inclined so as to facilitate the flow of the water of condensation. Through the use of such an arrangement, the moist air issuing from the apparatus is distributed in the work-room and around the machines contained therein.

The quantity of air and degree of moisture are regulated by means of globe-valves, *d*, and the temperature of the air is obtained at different degrees by modifying the volume of the water of injection by the valves of the pipe, H.

For forcing 600 cubic meters of air per hour into spinning and weaving rooms, the diameters of the different steam, air, and water pipes necessary for the installation are respectively 15, 150, and 40 millimeters.—*Revue Industrielle.*

EGROT'S STEAM KITCHEN.

IN establishments in which it is necessary to prepare food in large quantities, it is very difficult, in operating with large vessels, to obtain, through a heating by naked fire, an equal temperature in all portions of the materials to be cooked—certain portions being dried, or even carbonized, while others are far from having received the desired amount of cooking.

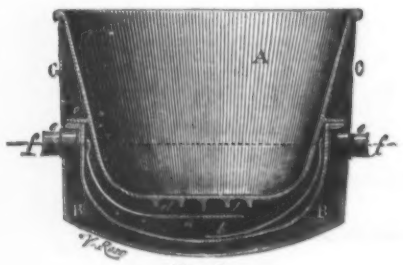


FIG. 2.

It was with a design in view of obviating such troubles, that Mr. Egrot was led to devise the system of cooking food by steam, such as shown in the accompanying cuts.

Fig. 1 gives a general view of the system, the details being as follows: 1. Generator for producing steam 2. Reservoir for collecting return water of condensation. 3. Apparatus for feeding the boiler with water of condensation. 4. Coal box. 5. Wood fire roasting oven. 6 and 7. Kettles for the preparation of soups, and for cooking vegetables. 8. Kettle for stews, bœuf à la mode, etc. 9 and 10. Pans for frying meats, etc. These various vessels are made of cast iron, and are surrounded with a jacket of plate iron,

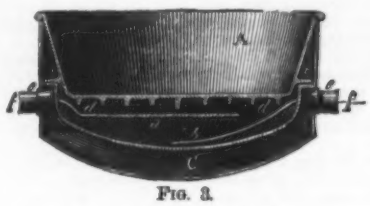


FIG. 3.

which prevents them from shocks (Figs. 2 and 3, C). They are movable on a horizontal axis, *f f*, resting on iron supports through the intermedium of hollow trunnions which serve to introduce the steam, and to give exit to the water of condensation. The steam enters through the tube, *a*, which is pierced with a number of small holes; and the condensed

FIG. 4.

water is forced into the tube, *b*, by the pressure of steam in the double bottom.

In the first kitchens that were constructed, the vessels had a spherical base (Fig. 4). But in these, the level of the condensed water in the double bottom rose too rapidly, soon reached the bottom of the kettle, properly so called, and

FIG. 5.

covered its surface. Consequently the foods were cooked as if by a water-bath. Besides, such vessels did not permit of roasting meats, since the juices and fat accumulated at the lowest part, and the pieces that happened to be a little above, in contact with the metal, soon became carbonized. For this reason, Mr. Egrot has adapted for the bottoms of the vessels a flat form, strengthened by transverse ribs that give them sufficient resistance, while in no way interfering with the transmission of heat.

FIG. 6.

All the apparatus of which the steam kitchen is composed are surrounded by insulating materials so as to prevent unnecessary losses of heat.

Mr. Egrot's system permits of considerable economy

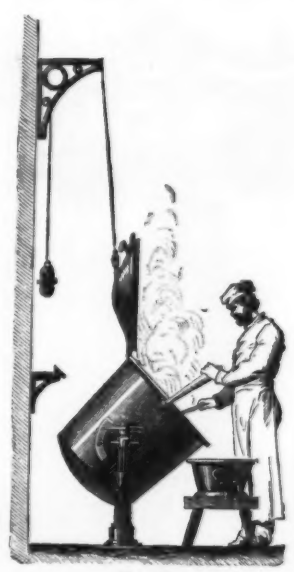


FIG. 7.

being attained, especially in the matter of fuel, the saving in this reaching 60 per cent. or more; for all fire-places are united in a single one, and the generater is fed by water of condensation kept at the highest temperature possible. By

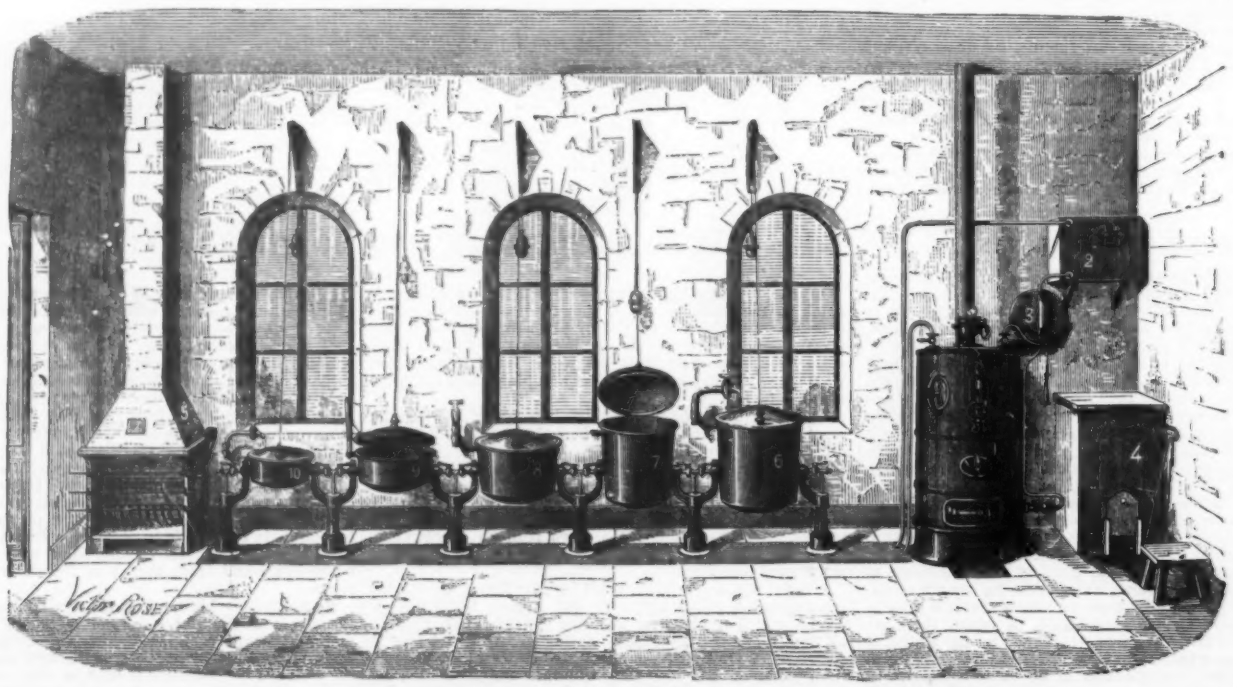


FIG. 1.—GENERAL VIEW OF EGROT'S STEAM KITCHEN.

the use of one of these kitchens the consumption of coal at the Pépinière Barracks, Paris, which was formerly 360 kilogrammes per day, has been reduced to 150 kilogrammes.

From a hygienic point of view, this system is one of the most advantageous; for the air is no longer vitiated by contact of foods with the iron stove, and the food is cooked to a turn.

We may note also the great cleanliness which exists in such a kitchen, through the isolated arrangement of the vessels, and the facility for keeping these clean by removing the generater to a distance. This latter may even be located in a room contiguous to the kitchen so as to thereby avoid smoke, soot, and ashes.

As for the facility with which these apparatus may be used, it is hardly necessary to speak of it: the cocks are provided with handles of different colors to distinguish the apertures through which the steam enters from those through which it makes its exit; the kettles and pans are made to swing, and may be fixed at any desired inclination for emptying or cleaning them; and the covers, as may be seen from an inspection of the figures, are balanced by counterpoises. Fig. 5 shows a vessel whose cover is arranged for cooking with partial evaporation; Fig. 6, the same vessel arranged for cooking with free access of air; Fig. 7, a vessel inclined so as to remove a portion of its contents; and Fig. 8, two coupled vessels forming a group in the middle of the kitchen.

FIG. 8.

There is a very large number of these steam kitchens now in operation in colleges, hospitals, etc., and up to the present time not the least accident has happened from them.—*Annales Industrielles.*

SCHONHEYDER'S GAS STOVE.

THE accompanying engraving illustrates a stove invented by Mr. W. Schonheyder, of St. Stephen's Avenue, Shepherd's Bush. A is the burner mounted on a swing bracket and surrounded by gauze wire to prevent the gas from being lighted from below. B is the glass chimney. C is a sliding cap over same, and which must be lifted up to allow of the bracket being swung to one side for the purpose of lighting the gas. D is the internal flue pipe for carrying away the products of combustion, and it is surrounded by a pipe, D_1, leaving an inclosed air space between them, which prevents the outer pipe, D_1, from being overheated and thereby burning the air in the room. E is a valve-box with valve, E_1, on its top, and which is shown closed, thus compelling the products of combustion to descend by pipe, F, and then to rise by pipe, G, finally escaping by pipe, H, to the chimney after having lost the greater portion of their heat by imparting it to the surrounding incoming fresh air. The pipe, F, is also surrounded by an outer pipe to avoid the overheating of the fresh air. The pipe, G, is single, the gases in it being sufficiently cool not to require the double casing. A drain pipe at the bottom of pipes F, and G, carries off the condensed vapors resulting from the cooling of the products of combustion. The fresh air is led from the outside of the building by suitable channels, and is carried upward by the large rectangular channel, H, which forms the base of the stove, is then brought into contact with the outside of the casing round F and the pipe, G, and warmed by them as before mentioned, and issues into the upper part of the room at I, as shown by the arrow. After spreading all over the room and circulating through it, the air is withdrawn by some aperture near the floor, and communicating with the same flue which carries off the cool products of combustion. The escaping air and the products of combustion keep the chimney hot enough to effect a sufficient amount of ventilation, and draughts are not felt at any part of the room.

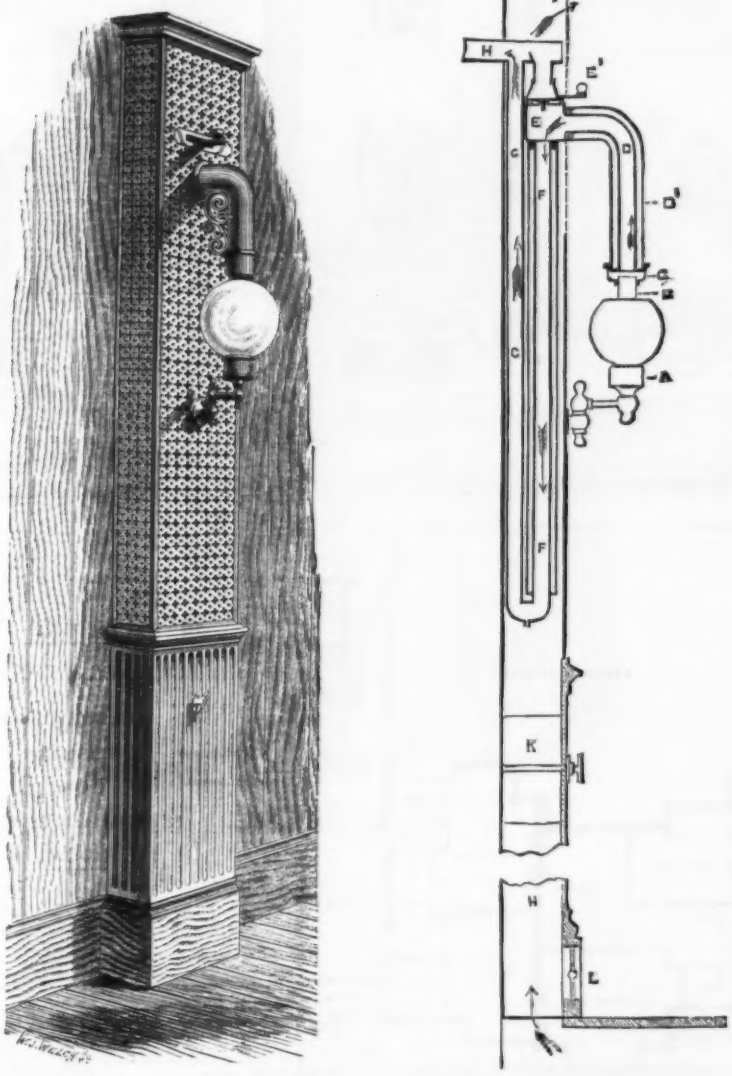
The stove can be used in combination with the ordinary fire-place, which then serves as the aperture for withdrawing the air from the room. When the weather is mild, but the light is still required, or the ventilation, or both, but not all the heat, then the valve, E^1, is changed whereby the products of combustion are sent direct to the chimney without traversing pipes, F and G, and therefore very little heat is imparted to the incoming air. For use in summer, or where the outer air is warm enough to be admitted direct, the valves, K and L, are provided, as also are ordinary ventilating valves placed in connection with the chimney near the ceiling of the room. By opening this said valve, and at the same time closing K and opening L, the fresh air is admitted to the floor or lower portion of the apartment, rises and carries with it heat from the occupants as well as some heat from the gas-burners, and finally issues into the chimney by the above named ventilator. By admitting warm air to the upper part of room, a cool air to the lower part, the passage of the air is gradual, without any sudden changes, and hence draughts are never felt.

The flat form of stove here illustrated is a considerable improvement on the round form first introduced, as it can be fixed at each side of the ordinary fireplace on the chimney breast or in the recesses at each side, and it does not interfere in any way with the ordinary fireplace, nor necessarily with the decorations of the room, but on the contrary, it can be made to conform with them. A large, round stove, about 2 feet 3 inches diameter and 18 feet high, with six lights, has been fixed in the new offices of the South Metropolitan Gas Company, where a stove of the pattern here illustrated is also in use. The test made by Messrs. Verity & Hunt was on a two light circular stove.

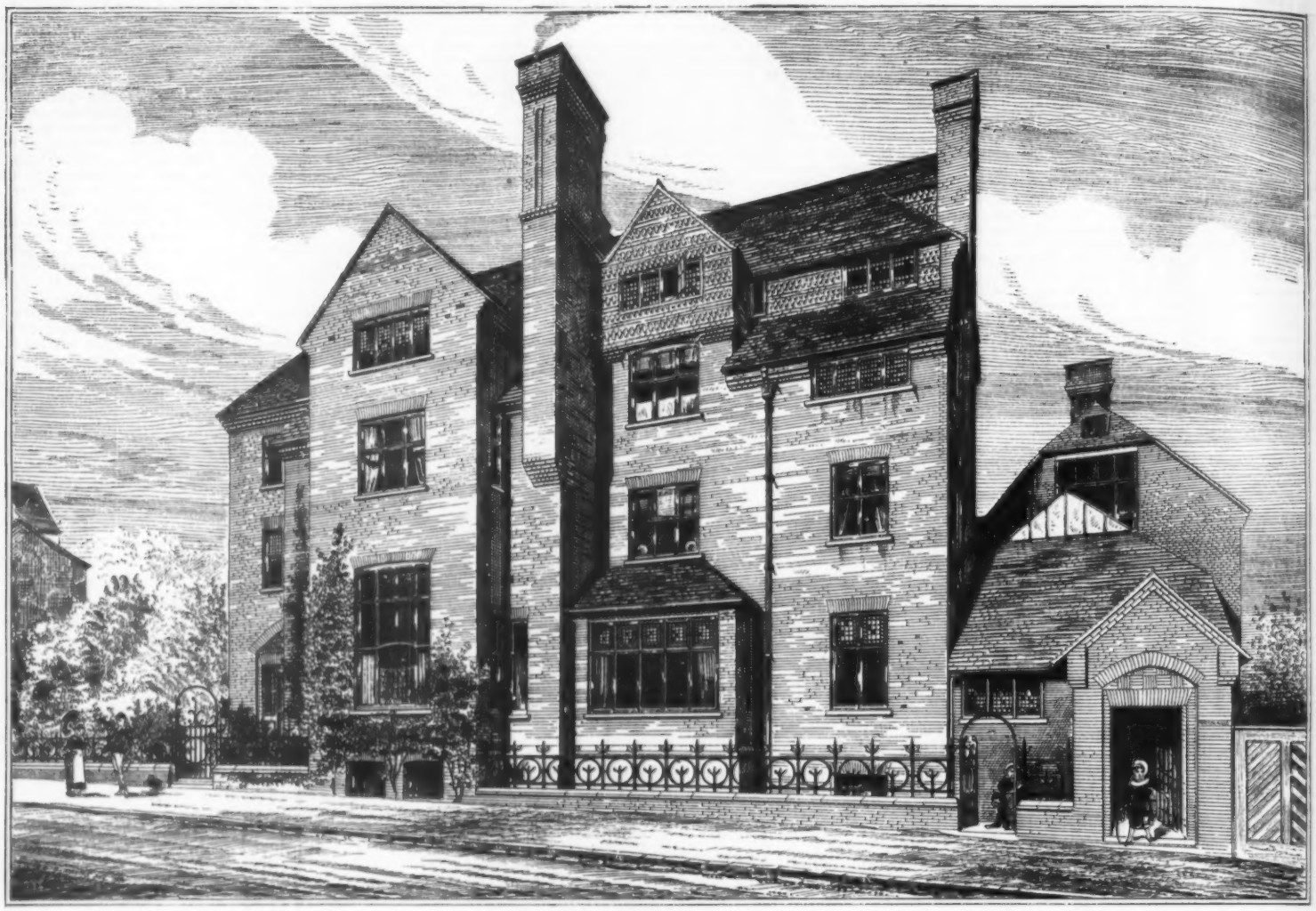
It would appear from the perspective view as if the whole of the part containing the warming pipes, F G, were perforated, but only the upper part is, by preference, pierced, as shown in section.—*The Engineer.*

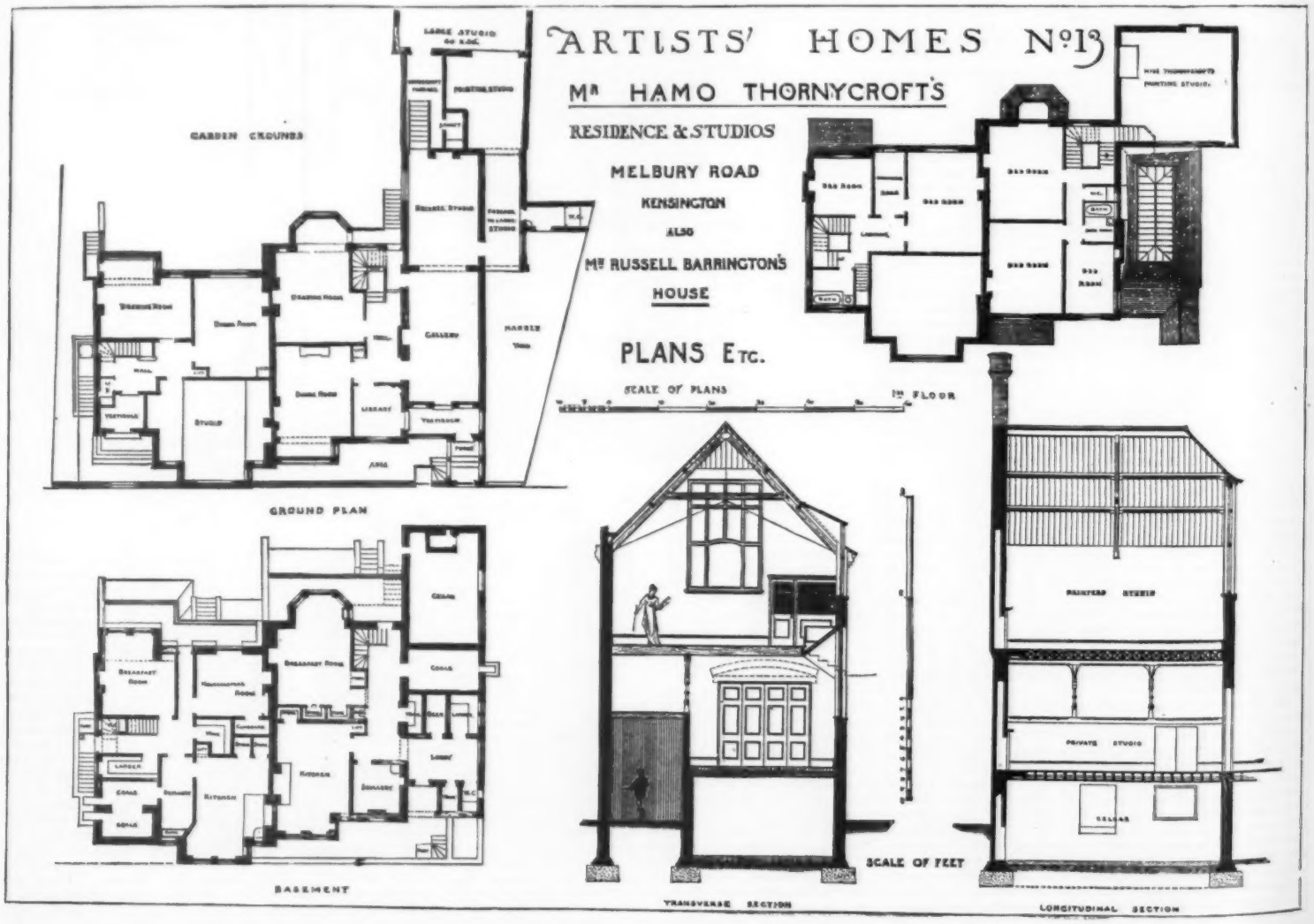
THE COAL FIELDS OF NAGASAKI.

THE field from which the main supply of coal for the Nagasaki market is obtained is situated under the sea and islands, and along all the coast line, extending northward from Cape Nomo, in the south, up to the entrance of Nagasaki Harbor, and from thence in a westerly direction, almost to Hirado shima, the most northerly of the Goto Islands. This field has an area of 900 square miles, but it is impossible accurately to define the limits either on the west or southern sides, owing to the fact that the strata here are totally submerged by the sea. Consul Jones states that the coal-bearing stratum of the Nagasaki district seems to be referred to the Tertiary period, though it is the opinion of Professor Nordenskiold, who devoted some time to the study of the rocks, that they might more justly be classed as Permian. The coal is described as being highly bituminous, of irregular appearance, inclining toward cubical, having, when freshly broken, a lustrous black appearance, which changes, by protracted exposure to atmospheric influence, to a dull rusty black. The known seams of workable coal vary considerably in thickness, the thinnest seam wrought being one barely three feet in thickness, which is worked at Hira-shima; and the thickest being an 18 foot seam, worked at Taka-shima. Consul Jones states that it is almost impossible, with any degree of accuracy, to state what the total thickness of workable coal may be, but the "Goto Tankosha," a mining company in whose hands the greater portion of the coal-field is placed, have already proved and worked at their Taka-shima mines, coal-seams of an aggregate thickness of fifty feet. The existence has also been proved, near Matsu-shima of two seams of coal, each measuring seven feet in thickness, and there are several seams of from four to six feet at present being worked on other islands, notably Koyaki, Iwo shima, and Okishima, but in a primitive manner, by native miners. At present the supply of coal is almost entirely derived from the workings of the "Goto Tankosha" at their mines, which are situated on Taka-shima, a small island of from 300 to 400 acres in extent, lying about eight miles southwest from Nagasaki. As far back as history can be traced, a few fishermen were the only inhabitants of this island, and in making fires to light their fishing operations, and in certain seasons to attract the fish by lights suspended from their boats, they found and used for this purpose the first outcroppings of the coal, which circumstance originally attracted attention to, and was the cause subsequently of discovering the existence of the coal-fields. Coal was known to exist in, and has been obtained from, the island by the Japanese for the last two centuries, but the quantity extracted has been small, and the mining operations as carried on by them simple and rude, consisting principally in following down the coal seams from their outcrop at the surface, until the quantity of water draining in from above became too great for their rude pumping appliances to deal with. This latter event generally occurred at a point varying from 100 to 150 yards from daylight, and when it took place the working was abandoned, and fresh outcrops prospected for. The system of working which was in use in these old native operations was of a very rude description, bearing a strong resemblance to the old method for extracting the vein in metalliferous mining. Most of the mining operations which are carried on by native miners, without the assistance of foreigners, still partake very much of this character, though they have been greatly modified by the example offered by the works which are being prosecuted under foreign supervision. At the present time the works are in the hands of a Japanese company, called the "Goto Tankosha," the miners being chiefly Japanese acting under the authority of a foreign manager and engineer. The average daily outcrop of coal from this company's mines is at present about 1,000 tons, with the capacity for supply double that quantity when required. The coal is obtained from three separate seams mea uring respectively eight, ten, and eighteen feet. As most of the workings extend from the island out beneath the sea, considerable difficulties have to be encountered in contending with water, engines with a total of 200 horse power being used in pumping. The dip and rise of the stratum at Taka-shima being very steep, the haulage is carried on by engine power—the power being transmitted through steel-wire ropes of two and a half inches in circumference. The aggregate length of engine roads below ground is over three miles. As the workings have extended, large quantities of fire-damp have been encountered, and this has necessitated a very elaborate system of ventilation. Fans are in use for this purpose, which pass a quarter of a million cubic feet of air through the mine per minute. All the mines are illuminated by means of locked safety lamps, the "Clanny" being the form more generally in use. Several severe explosions have occurred in the mines, the last taking place in April, 1880, when several miners were killed. There are about 4,000 workmen in and about the Taka-shima mines; these include a very competent staff of mechanics. The coal is conveyed in native junks from Taka-shima to Nagasaki, about 100 of these being kept in constant employment. The laborers and miners of the Taka-shima Coal Company live on the



IMPROVED GAS STOVE.




ARTISTS' HOMES No13
Mr HAMO THORNYCROFT'S
RESIDENCE & STUDIOS
MELBURY ROAD
KENSINGTON
ALSO
Mr RUSSELL BARRINGTON'S
HOUSE
PLANS Etc.
SCALE OF PLANS
1st FLOOR
GARDEN GROUNDS
GROUND PLAN
BASEMENT
TRANSVERSE SECTION
LONGITUDINAL SECTION
SCALE OF FEET

inland, in houses built by the company in Japanese style, and these form a considerable village. They are supplied with provisions by the company at cost price. The wages for ordinary labor are from fourteen to forty-five sens per day; skilled labor and the foreman of gangs receive higher wages, about seventy-five sens per day. The miners are divided into parties or squads of five persons, two to dig or cut the coal, and three to carry it to the tramways. These are paid in proportion to the quantity of coal they handle—that is to say, by the cattie. Women and children are employed in the mines, and receive the lowest wages, viz., fourteen sens per day. A day's labor consists of eight hours, either by day or night. A miner is at no expense for clothing, a straw sandal being usually his only garment. Consul Jones mentions a curious circumstance in connection with the subject of coal-mining, which is, that notwithstanding the abundant supply of coal, its proximity, convenience, etc., it is not used by the Japanese for heating or cooking purposes in the city of Nagasaki. The houses are constructed for a summer climate, without fire-places or chimneys, and are heated, when the weather is cold, by charcoal burned in small portable vessels, made either of metal, porcelain, or wood, called "hibachies." The cooking also is done over the "hibachi." The Japanese Government have also lately opened out a new field of coal in the Higo district of the province of Nagasaki, at Mūke. This new colliery is supplied with all the latest foreign mining machinery, and is carried out under the superintendence of a foreign mining engineer. It has an output capacity of from 300 to 400 tons per day, and the coal is shipped from the port of Kuchinotsu, which has been opened to foreign ships for that purpose. The yield of coal from the Mūke mine, for the year 1880, amounted to 142,235 tons, of which 17,904 were sold in Japan, and 124,331 destined for consumption in China.

ARTISTS' HOMES: NO. 13—MR. HAMO THORNYCROFT'S HOUSE.

MORETON HOUSE, with its studios, which we illustrate, is an unusually interesting building, and it is the first sculptor's house which has been given in our "Artists' Homes" series of illustrations. It is erected in the Melbury Road, Holland Park, Kensington, and belongs to Mr. Hamo Thornycroft, A.R.A., and included in the same structure are several studios for painting purposes, inasmuch as Mr. Thornycroft's family is, in more senses than one, correctly described as a family of artists. The building was erected by Mr. Thornycroft himself in 1876, with the advantage of suggestions and technical knowledge afforded by Mr. J. Belcher, architect. The builders were Messrs. Adamson & Son, of Turnham Green. Its plan includes really two distinct residences, the second house being occupied by Mr. Russell Barrington. One of the necessary features to a sculptor's studio is, of course, a side-entrance, or back way, through which large blocks of marble and loads of clay, or big models, may be brought in. This, in the present instance, has been very cleverly contrived at the side from the Melbury Road by a passage-way taken out of Mrs. Thornycroft's studio behind the statuary gallery, on the ground floor, and under Miss Thornycroft's painting studio above. The sections clearly show how this is managed, and the alcove or recessed space in the lower studio forms an admirable feature really for the exhibition and display of busts and other small statuary. Another necessary condition to be observed in planning a sculptor's studio is its isolation from the house, and this is chiefly, of course, due to the dusty nature of the work to be done there; and, in fact, it is the dust which renders it a difficult matter to treat a sculptor's studio with any degree of finish or decorative character. Mr. Thornycroft's studio is cut off from the house by a prettily arranged conservatory; and it is a lofty structure 60 ft. long by 30 ft. broad. Extending beyond this is a "private den," or "own room," with a low alcove like a garden-house at the end, from which peeps of the grounds may be obtained. Returning to the ground plan, it will be noted that the entrance is by a side approach leading to a vestibule, from which either the private house itself is reached, or the statuary gallery with its top light and salmon-tinted walls. Divided from this gallery by a curtained arch is Mrs. Thornycroft's studio, as already described, and beyond is the conservatory leading to the main studio. Thus a direct communication is secured with the entrance without necessarily going into the private part of the house at all. This latter is conveniently contrived, and the planning of the kitchen-door in the sub-basement is light, lofty, and well-arranged. A garden-way is obtained from the staircase hall, as well as from the drawing-room bay, which overlooks the grounds, with Mr. Val Prinsep's house in the distance. The other points of the plans, and also the architectural treatment of the elevations, will not require any description, as the drawings explain themselves. Suffice it to say that the walls are of red brick, with Yorkshire tiles on the roof, and red-shaped tiles on the upper walls. A fourth studio is obtained on the top floor overlooking the garden. The gallery, hall, and studios in the house are heated successfully by means of hot-air warmed in the cellar under Mrs. Thornycroft's studio by passing over a hot-water coil, fresh air being admitted on the garden side under the garden steps. The studio in Mr. Barrington's house runs up into the first floor, as will be seen by reference to the plans.—*Building News.*

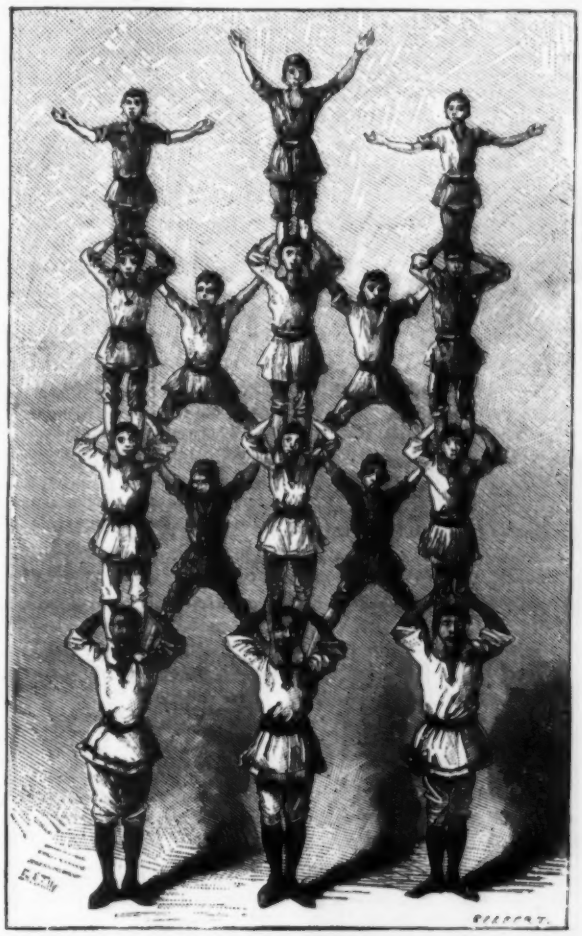
[Artists' Homes, No. 14, was published by inadvertence prior to this. For No. 14 see SUPPLEMENT, 299.]

A CURIOUS LIVING STRUCTURE.

IT is not so much a feat of strength as one of dexterity that is represented in the annexed cut; and the skillful equilibrists who are here performing, and whom we had occasion to see some time ago at the Paris Circus, are knowingly or unconsciously applying the ordinary principles of construction in the building of their human structure. This scaffolding may, in fact, be likened to those frameworks which form the skeletons of a large number of cheap mortar structures in the precincts of Paris. Three large vertical posts, formed by four superposed persons, are tied by four St. Andrew's crosses, formed by four young individuals whose feet and hands represent the tenon and mortise joints of an ordinary frame. Such tying prevents the only inclination of which there is any danger—a lateral one—since, in a backward and forward direction, the feet of the three men at the base form a sufficient foundation. The hands of the men of one story, holding the legs of those of the upper, contribute also to give rigidity to the vertical posts in a transverse direction.

What are we to say now of the skill necessary to raise such a living wall, whose equilibrium presents a certain stability only when it is complete?

Such scaffoldings recall those exercises which were engaged in at Venice from the Middle Ages up to the time of the Revolution, and the contests of the Castellani and Nicoloti. At present, these exercises are more particularly indulged in by Negroes, Indians, Chinese, and Japanese. But it must be recognized, however, that our circus actors likewise succeed in executing genuine marvels of dexterity. To return to the example that we have cited of this, we shall give figures to prove that strength plays only a small part in the exercise shown in the cut, and for which dexterity is the indispensable quality. The three negroes at the base of the pyramid are men of from 30 to 25 years of age; those of the first story are from 18 to 20, and the top of the edifice is formed of children of from 12 to 14 years. The three men at the base, then, are supporting thirteen youths of a mean weight of a hundred pounds, or a total weight of 1,300—about 434 pounds per person. Although neither our readers nor we could probably do as much, it is not rare to find strong market-men who carry the same, or a greater weight, and who carry it, too, sometimes up several stories. An example of one of these persons is cited who carried on his shoulders three bags of flour weighing 1,050 pounds, but he broke down under a load of four bags, or 1,443 pounds. Certain acrobats, by bracing themselves under a table, lift, without perceptibly moving, 1,780 pounds.



A LIVING STRUCTURE FORMED BY ACROBATS.

But the most wonderful exhibition of muscular power that can be cited was that accomplished at Derby, May 28, 1741, by an English wrestler, Thomas Topham. This man, who was then 30 years old, lifted, with nothing but the muscles of his neck and shoulders, with the aid of a strap passed around his neck, three casks filled with water of a total weight of 1,836 English pounds.—*La Nature.*

CLEANING PLATES.

CLEANING plates is, perhaps, the most unpleasant operation that falls to the lot of the amateur photographer, or, perhaps, I ought to speak in the past tense and say that *did* fall to his lot, for since commercial plates have become so cheap the amateur who prepares his own is the exception rather than the rule. Still, among the thousands who now practice photography simply for amusement, there are many who still prepare at least a portion of the plates they use, and there are very many more who at the end of a season—or, perhaps, very long before the end—find themselves the happy possessors of a vast number of spoilt plates which, as they stand, are not only of no use but are absolutely a nuisance.

Even the conscientious man, who occasionally makes his own emulsion, dreads the trouble of cleaning off the old films and bringing the plates into proper condition for recoating, while the completely hardened "purchaser" is unwilling to throw away what represents—or ought to represent—so much cash value; and so both classes go on accumulating what is to them, practically, a mass of useless rubbish. It seems strange that there should be no market for such goods; but the explanation is, perhaps, to be found in the fact that such cheap glass has come to be used for the preparation of dry plates that it is not worth the while of any one to clean glass with a view to pecuniary profit.

In my own case "time is money," and, though I, perhaps, do not gain *much* by reusing my spoilt plates, I have come to consider it worth while, and, what is more, I get rid of, in a satisfactory manner, what was once *the* nuisance of my laboratory. With the barest hope that my experience may help some brother amateur I will narrate how I have converted into clean and usable glass a vast heap of spoilt plates, the accumulation of nearly three years.

As a prelude, let me give a word or two of advice on the subject of keeping spoilt plates, if they are intended to be used again. In more ways than one the value of this advice has been forced upon me. First of all, do not throw your plate, if it fog or prove under-exposed, into the sink, nor leave it lying about the developing table or elsewhere to "catch" any dirt, chemical or otherwise, that may be going about in search of a final resting-place. If you use ferrous oxalate developer be specially careful in this respect, for the stains of oxide of iron, when they once dry on to glass, are very difficult of removal. If left knocking about "anywhere" the plates also get scratched and chipped at the edges—perhaps cracked. The first state leads to irregular films when the glass is recoated; the second most probably to nasty cuts, owing to fracture of the cracked glass during the removal of the film. Lastly: if you spoil a plate in development, from any cause whatever, wash it carefully, but do not fix it; set it up to dry in a proper place, and your reward in the future will be commensurate with your care.

Now to come to the cleaning operation. As most of us know—at least those who have tried—a gelatine film requires more "removing" than a collodion one. I have seen tried—and have tried myself—placing the plate in hot water, the softened film being then polished off in a nasty, smeary mess, and each plate taking as long to clean as a dozen ought to do. That, I say most emphatically, is the way "how *not* to do it." The gelatine film, rendered partially insoluble by the developer, will not succumb to mere hot water, and all the "elbow-grease" in the world then only helps to smear it more and more over the glass. Instead of hot water use cold, and treat the plates to a soaking of half-an-hour or an hour. With some films—it depends upon the gelatine used—half-a-minute's soaking of the dried gelatine will enable you, by first raising one corner, to strip off the whole film in a sheet, leaving the glass practically clean. But that plan is not to be depended upon; better give the half-hour's soaking, and then proceed as follows: Procure a deep trough or dish of porcelain, or other material (I use a wooden dish about four inches deep); fill this to about half its depth with water. Provide also a piece of board about half-an-inch thick and about twice the length of the plates to be cleaned; also another piece about three inches square (this of hardwood), with one edge planed nice and square. The first piece of wood is laid in a sloping position—one end resting on the edge of the trough, the other dipping into the water; the second piece is used as a scraper for removing the gelatine films.

When you are ready to proceed, have the plates which have been soaking in a tub at one side of you; take them out one by one, lay them face upward on the sloping board, and two or three vigorous strokes of the scraper will remove every particle of film from the surface. Drop that plate into a vessel of clean water on the other side of you, and proceed with the next. Single-handed, you will find that in an hour's time you have removed the films from twelve or fifteen dozen plates of moderate size—say half-plates to 7½ × 5—and have left them in a condition requiring little more than drying, *provided they have not been stained and dirtied by chemicals* through being left about the sink. When such is the case, it will be necessary to use the solution of bichromate of potash and sulphuric acid, followed by a good washing in clean water.

To dry the plates, have beside you a basin of hot water—as hot as possible—and two or three clean, soft cloths. Take the plates one by one from the cold water vessel into which they were placed after removal of the films, and, holding them by one corner, dip them for two or three seconds in the hot water, and proceed at once to dry and polish with the cloth. It is astonishing how quickly they are dried; the heat imparted by dip into the hot water helping

very materially. As soon as one cloth begins to show signs of dampness hang it to dry before the fire and take a fresh one. If properly polished—which may be done in a few seconds—these plates require no further treatment, except dusting, before the application of another coat of emulsion.

One word on the subject of economy. Do not throw away the scraped-off films. As a matter of experiment I recently saved and dried separately the films from five dozen 7½ × 5 plates—some of my own manufacture, the rest by different commercial makers. I recovered over 160 grains of metallic silver—all the plates having been unfixed. This, as a special trial carefully made on a small scale, gave a probably higher return than would be obtained in practice; but it shows the films are worth saving. If dried and mixed with paper cuttings the nitrates in the latter will help the combustion of the gelatine, and the whole can be burnt together without trouble.

In conclusion I may say that I calculate I saved a few pounds, with the expenditure of very little trouble, by simply going in for CLEANING PLATES.—*C. Beckett Lloyd, in Brit. Jour. Photo.*

NEPENTHES COCCINEA ×.

THIS is one of the hybrids of American origin which have been introduced into British commerce by Mr. B. S. Williams, of Holloway, in whose nursery we took the following note:

PITCHER PLANT.—*Nepenthes Coccinea* ×.

Pitchers 6 by 3 inches, crimson slightly speckled with yellow, flask-shaped, pointed at the base, distended below the middle, broadly cylindric above, wings deep fringed, mouth ovate acute, slightly protracted at the back; rim broad, finely ribbed; ribs party-colored red and black; throat greenish, speckled with red; lid ovate oblong, smaller than the mouth, greenish, striped and speckled with red; apex of leaf acute.

It is evidently one of the most desirable forms of cultivation so far as beauty is concerned, but we can say nothing at present as to its habit.—*The Gardeners' Chronicle.*

NEPENTHES—PITCHER PLANTS—AND THEIR CULTURE.

PLANTS which, in addition to the moisture given off by them in an ordinary way by evaporation, also secrete copious supplies of liquid in their pitchers, may naturally be expected to require a large supply of water, and such is the case with the nepenthes. This being so, it is hardly necessary to add that success in their cultivation depends much on a free supply of water both in the atmosphere and at the root. Our stoves contain no genus of plants more interesting than the pitcher plants. Their long arching leaves and beautifully marked pitchers never fail to arrest attention. Therefore, no collection of stove plants ought to be without at least one nepenthes. Some plant growers appear to object to pitcher plants on account of some supposed difficulty regarding their cultivation; and yet it may, with safety, be said that, when given the right treatment, no plants are less troublesome. A hundred, nay fifty, years ago, when the only species of nepenthes known was *N. distillatoria*, and when a high temperature along with a moist atmosphere was not easily obtainable, the cultivation of tropical moisture-loving plants must have taxed the skill of the most ingenious. We can therefore understand why Loudon should write of nepenthes as being "extremely difficult" to cultivate, although he proceeds to say what the most successful cultivators of to-day would support, namely, that they "require a very damp atmosphere, much heat, and not too much light." This is exactly what they do require, and in these days of advanced horticulture these conditions are easily secured.

Soil.—Any moisture-retaining, sweet material in the way of soil will suit nepenthes, the best mixture perhaps being equal parts of peat fiber and sphagnum with a few lumps of charcoal and a little sand. I have grown some species tolerably well in an ordinary mixture of peat and loam, but I should hesitate to recommend it for general use. They may be placed either in pots or teak baskets, the latter being perhaps the best if the soil in them can be kept sufficiently moist. In the case of pots plenty of drainage should be given; they should, indeed, be half filled with clean crocks. In potting careful manipulation is necessary, as from the fineness and brittle character of the roots they are very easily injured. The soil should be pressed firmly into the pots or baskets, sufficient room being left for a good supply of water They should be suspended from the roof or elevated on pots, so that the pitchers may have plenty of room to hang down. Water should be given every day and the syringe used as often as possible in summer, but the supply of water both at the root and overhead should be diminished during the colder months. They must, however, never be allowed to become dry at the root, or serious injury will be the result. One frequently sees nepenthes producing large, healthy leaves, but no pitchers. In such cases the plan to adopt is to cut them down to within an inch or two of the base and force them to break afresh. The young shoots thus induced to start will be found to form pitchers freely. In some species, such as *N. rafflesiana*, *N. distillatoria*, and *N. phyllamphora*, long shoots may be encouraged and trained horizontally, which encourages them to develop robust pitchers, differing altogether in shape from those produced by small plants, these latter being broad at the base, while the former are gradually narrowed from the lid downward to the thickness of the stalk at the bottom.

Cuttings.—On the plants becoming leggy, they may be cut down low and the tops made into cuttings, a leaf and an eye being sufficient. Cuttings of this description, and also of larger size, strike in about six weeks in a warm propagating frame; and if the plunging material used be cocoa-nut fiber, all that is necessary is to put the cuttings into the fiber and keep it moist until they are rooted, when they may be lifted and potted into the compost mentioned above. I have had tops one foot long, with half a dozen pitchers on each of them, root under this treatment without suffering in the least. If a frame with bottom heat is not at hand, a flat pan filled with water and some two and a half inch pots may be used, the pots being inverted in the water, and the cutting placed through the hole at the bottom, but not allowed to touch water. Over the whole place a large bell-glass, and, thus circumstanced, if set in a high temperature, the cuttings will soon callous and emit roots. Thrips and scale sometimes infest nepenthes, and for their destruction strong tobacco water is the best mixture that can be used. The skill of the hybridist has been brought to bear on these plants; but, although many distinct and beautiful kinds have been procured thereby, the result cannot be said to have been wholly satisfactory, so many hybrids possessing no distinctive characters having been sent out as new and distinct kinds. The species deserving special attention are:

N. Rafflesiana.—This is one of the best of pitcher plants, and one of the least difficult to manage. It is a robust grower, and has large bright green leaves, the midrib of which lengthens out to a length of from one foot to three feet, and bears at its extremity a large pitcher from five inches to nine inches long, and about four inches in diameter. The wings are crested and the mouth gradually narrowed to a raised hinge, on which the lid is placed. The surface of the pitcher is pale green, thickly spotted with deep purple. Under proper culture this species produces pitchers in abundance, and it is easily propagated, properties which unfortunately do not belong to some other kinds. It is a native of Borneo, Sumatra, etc.

N. hookeriana is by some considered to be a variety of the foregoing, but horticulturally it is abundantly distinct, being of stiffer habit, and bearing pitchers quite different in form from those of *N. rafflesiana*. A large plant of this kind produces fine pitchers which are of a darker hue, more rotund in form, and with a shorter hinge than in *N. rafflesiana*. It is a native of Borneo, etc.

N. sanguinea is one of the rarest and most select of pitcher plants, owing to the difficulty experienced in its propagation. It has triangular smooth stems and leathery leaves, which are sessile and stem-clasping. The pitchers are from six inches to twelve inches long, rather narrow, downy, and dark crimson in color. This is a slow-growing species, and at present limited to a very few collections. It is a native of Malacca.

N. veitchi is a distinct and beautiful plant, often confused with *N. lanata*, to which it bears a rather close resemblance, The leaves of this species are rather thick and leathery, and are covered on the under surface with rusty colored hairs. The pitchers are about six inches long, about four inches broad, hairy, and have two rather broad wings. The rim round the mouth is broad and toothed, and is deep red colored, reminding one of the gills of some fishes. It is a slow grower. Native of Borneo.

N. hirsuta, generally known as *N. seylanica rubra*, is a pretty little species with rather short leaves and long handsome green pitchers, blotched with reddish brown. *N. phyllamphora*, *N. gracilis*, *N. albo-marginata*, and *N. khasyana* are other handsome species among those introduced to gardens.

N. Rajah.—This, probably the grandest of all the species of nepenthes, is thus described by Sir J. D. Hooker: "This wonderful plant is certainly one of the most striking vegetable productions hitherto discovered, and in this respect is worthy of taking place side by side with the *Rafflesia arnoldi;* it hence bears the title of Rajah Brooke, of whose services in its native place it may be commemorative among botanists. The leaves are from twelve inches to twenty-four inches long, very coriaceous and glabrous, with indistinct nerves. The broad ampullaceous pitcher is six inches in diameter and twelve inches long; it has two fimbriated wings in front, is covered with long rusty hairs above, and studded with glands within. The margin is scalloped into bold undulations, and the lid is sub-orbicular, ten inches long and eight inches broad." *N. rajah* is a native of Mount Kaina Balu, in Borneo, at a considerable altitude, where it was found by Mr. P. C. Veitch and Mr Burbidge when collecting for Messrs. Veitch, who hold the entire stock of it, and by whom plants of it have been exhibited at various times. As yet no pitchers of the size which this species is known to bear have been produced in this country, although there is every reason to believe that we shall soon see some of these gigantic productions on cultivated plants.—*The Garden.*

ORNAMENTAL ARBORICULTURE.*

By PROF. ROBINSON, of Salem, Mass.

To make a plantation which shall contain a desirable variety of trees adapted to the situation in which they are to grow, and calculated to remain a lasting benefit, requires a knowledge of physical geography, especially that which relates to the influence of climates upon plant life. Modern science teaches us that nature has, in the countless ages of time, evolved for each and every climate a class of plants especially adapted to the influences by which they are surrounded. She has, in particular instances, by gradual and imperceptible changes, adapted groups of individuals of a species to flourish in a climate differing totally from that in which other individuals of the same species are found. Hence, individuals taken from one locality may be perfectly hardy, while other individuals of the same species from other localities fail utterly to endure climate. For example, the small-leaved magnolia, taken from Massachusetts or the Middle States, is perfectly hardy here, while plants of the same species brought from Florida would not survive a single Massachusetts winter. Under the present theory of the distribution of species, based upon a careful study of geology, our existing flora is considered, with a few rare exceptions, to have been disseminated from a common center at the north, and to be the result of the inexorable law of the survival of the fittest species or individuals for the places they were forced to occupy. It is useless, therefore, to attempt to remove a plant from a

PITCHER PLANT.—*Nepenthes Rajah.*
(Native of Borneo.)

climate to which its ancestors have for ages of time become inured, and expect it to thrive in a different one. We should not give a moment's thought to a proposition to plant the *Victoria regia* of the Amazon in the pond on Boston Common; yet with trees attempts hardly less absurd have been persisted in, simply because the climatic conditions of the regions from which it has been attempted to introduce them were not studied, the latitude from which they were taken only being considered. A glance at a map of the northern hemisphere shows us that the configuration of the east coast of the continent of Asia is quite similar to that of Eastern North America, and that in the Pacific Ocean, as well as in the Atlantic, a warm ocean current, commencing at the southwest and flowing across the ocean, disappears at the northeast. Therefore, the coast climate of one continent may be expected to closely resemble the corresponding coast climate of the other, which, in point of fact, it does, the climate of northeastern Asia resembling that of New England and Eastern North America, while that of California and Oregon is not unlike the climate of Western Europe. There are also, in various portions of the globe, certain conditions which tend to produce local climates quite different from the surrounding regions, and, in some respects, not unlike our own. Some such districts are already known to us, and others may yet be discovered. Working upon these facts, we may arrange in order the regions from which we are obliged to select trees for cultivation in New England, and beyond which, unless in rare, exceptional cases, it is useless to go to add to our collections. This order is as follows: 1. The Alleghanian region of North America, which includes New England and Canada, and extends southward to the mountains of Northern Georgia and Alabama, and broadly to the eastern base of the Rocky Mountains. 2. The eastern coast of Asia, north of about latitude 38°, and including Northern China, Manchuria, and Northern Japan. 3 Regions with climates not sufficiently differing from that of New England to interfere with the adaptability of the plants of such regions to our climate. The Central Rocky Mountain region, portions of Siberia, the Caucasus, Turkestan, and possibly Thibet, are illustrations. 4. To the plants from the regions already

* A paper read before the Massachusetts Horticultural Society.

indicated may be added certain cosmopolitan species which inhabit widely different localities, and seem to flourish everywhere in the Old World.

To the Alleghanian, the first of these regions, too much attention cannot be paid, for here in a comparatively limited area is found a more extensive collection in number of species of desirable forest trees than is furnished by any region of similar size in the temperate zone, with the possible exception of Japan. There are more species than is possessed by the whole continent of Europe. Neither do the trees from this region require to be experimented with to ascertain their fitness for cultivation in our grounds, for they are of our own flora. But before entering upon the Southern Alleghany Mountain region, where there are many species not natives of New England, we need go no farther than our own woods to find many of the most desirable trees to plant for ornament; trees which in Europe have been eagerly sought for two centuries as great prizes, but which in our own country have been too long neglected for general planting. What tree is more desirable in every way than the sugar maple, or for single specimens more interesting than the hickory? Our oaks rank among the most magnificent trees in the temperate zone, while the tupelo, beech, sassafras, hornbeam, the birches, and the ashes among the deciduous trees, and the white and red pines and hemlock among the evergreens, are all valuable trees for ornamental purposes. To these may be added from among the lower growing species the hamamelis with its November flowers; the gorgeously fruited sumacs; the amelanchier, too often overlooked; the dogwoods, including the conspicuous *Cornus florida*, and the viburnums. All these grow naturally within twenty miles of this spot. There are besides, in the immediate neighborhood, a number of trees, which, although not suited for all soils and situations, are, nevertheless, adapted to certain localities. Among such are the American elm, which flourishes best in the alluvial river meadows, and the true white cedar of the low swampy lands. As previously stated, one of the greatest storehouses for tree species in the temperate zone is the region of the Southern Alleghany Mountains. In Pennsylvania and the mountains southward are nearly two score of trees which, although belonging to the same flora as our own, are not natives of Massachusetts, but are certain to succeed in our ornamental plantations.

There are five species of magnolia, most of which are considered as rare trees in cultivation. We have the buckeyes —the red and yellow flowered larger species, and the white flowered shrubby one; the Cladrastis or yellow wood, fine specimens of which are now to be seen on many of the older estates in this vicinity, and one magnificent specimen at the Botanic Garden, Cambridge, over 30 ft. high, with a trunk 2 ft. in diameter. There is the red-bud, which, with its prodigality of deep pink flowers, presents in spring a most beautiful appearance. Among the plants of the rose family are two species of Cratægus, one somewhat resembling the scarlet thorn; and the American crab apple, desirable for its fragrant flowers and marketable fruit. We have the Viburnum prunifolium, resembling our sheepberry, but a larger growing tree; the Halesia or silver-bell tree; and the persimmon, whose fruit ripens in this vicinity and should be added to our garden products, and find the place it deserves upon the exhibition tables of this society. The Virginia fringe tree, although frequently seen in cultivation, should be more extensively planted, and the winged and slippery elms and the chinquapin are not so often seen as they deserve to be. Of the oaks there are a large variety. Besides the eight species, more or less common in the woods of this vicinity, there are five others which may be added from the region a little south of us, that are now seldom met with in cultivation here, which differ in foliage and in fruit strikingly from our native species. Among them are the willow oak, the pin oak, and the burr or overcup oak. This last species is likely to prove the rival of the white oak in the value of its wood for mechanical purposes, on account of its durability in exposed situations, where it resists decay seemingly longer than that of any other species. Among the conifers are the Table Mountain pine and the bald cypress, both of which are perfectly hardy. To this list may probably be added a newly discovered hemlock, with larger cones and longer leaves than our own, known as Tsuga caroliniana, and the Rhus cotinoides (somewhat resembling the European smoke tree) which has been lately re-discovered in the mountains of Alabama. From the west of this region, and yet within the limits of its flora, are the Fraxinus quadrangulata (blue ash) of Michigan, a beautiful forest tree with valuable timber, and the western Catalpa, but recently distinguished from the southern species with which it has been confused. This last adds to our collections, without doubt, a tree at once beautiful as an ornament, and of great value on account of its almost imperishable timber. There are also at the west the Ulmus racemosa and Carya sulcate, or western shagbark hickory, both fine trees. At the north are the gray pine and white spruce, the latter one of the best of its class that we can cultivate.

The second region to which we may look with the expectation of adding extensively to our collections will be, as indicated previously, Manchuria, Northern China, and Northern Japan. There are already in cultivation from these countries a great many valuable, ornamental plants, but still more may be added. Among those familiar to us from China and Manchuria are the wistaria, deutzia, and weigela, all of which are now widely distributed in our gardens, as is also, though perhaps less extensively, the Magnolia conspicua. Of the trees from this region which are likely to find their way into general cultivation as they become more accessible are several species and garden varieties of magnolia, a tulip tree, the Phellodendron amurense, the Chinese tamarix, a much finer and later flowering species than the European tree, which is commonly met with in cultivation; a linden, a horse chestnut, and several maples, one of which, a variety of Acer tataricum, bears deliciously fragant blossoms. There is also Cladrastis amurensis, a relative of our well known yellow-wood; a honey locust, a gymnocladus resembling the corresponding American species; a hawthorn, two plums, an ash, two birches, a pterocarya, which may be described as a relative of our hickories; besides an oak and the Manchurian walnut These are all deciduous trees. Among the conifers are the taxodium, occasionally met with here under the name of Glyptostrobus; the Chinese juniper, which much resembles our own red cedar; the pseudo-larix, a curious relative of the larch; and two pines, one of which, Pinus bungeana, common in the vicinity of Pekin, is at once recognized by its white bark. To the west of this region, in Siberia, are the caragana, an elm, and Picea obovata, all of which are desirable trees for cultivation here.

Japan, however, can probably furnish more desirable trees for New England ornamental plantations than even the continent of Asia. Already there are many species both of woody and herbaceous plants in quite general cultivation from that country. Among the Japanese trees not known to succeed perfectly here are several maples, including the well-named species, Acer polymorphum. This little tree has already won the admiration it deserves, and is rapidly finding its way into our collections in numerous varieties, some of which, when judged by the standard of beauty, and their ability to withstand the hot summer sun, are much more desirable than others. Nearly allied to the maple is the Negundo cissifolium, and also thoroughly tested are the sophora and the curiously fruited, yellow-flowered kœlreuteria. Two apples and the idesia are perfectly hardy, and there may also be added a chestnut, a walnut, and an alder, which have proved satisfactory, besides the phellodendron japonicum, the zelkowa, an ash, two birches, and more than one oak, which, although no doubt exists regarding their hardiness, have not yet been in cultivation here long enough to be considered as tested. Among the Japanese conifers we find an unusually large number suitable for our purposes—far more than can be obtained in any other region. Of the pines there are three desirable species; one, the Pinus densiflora, has been introduced under the name of Pinus massoniana, which belongs to a more southern Chinese species, not, probably, hardy with us. There are two spruces, a hemlock, closely resembling our own, a larch, and the umbrella pine (Sciadopitys), already thoroughly tested here. We have besides a long list of retinosporas, which some recent authors have placed under the old genus Thuja. They are more nearly related to our true white cedar than any other New England species. Many of the varieties of the retinosporas, of which there are a great number in cultivation, are very graceful and interesting plants. Of the permanency of these varieties not much can be said. Actual observation proves many of them to be but juvenile forms of well-known species, which, as they grow older, change their characters and take the normal forms. Carrière, a French writer on the Coniferæ, has happily called them the "larval forms" of the mature plants. All the retinosporas of our gardens may probably be referred to two or three typical species, although some of the varieties may prove more permanent than others.

The cultivation of ornamental plants has been practiced in Asiatic countries for a great length of time, and hence more garden varieties may be expected from this region than from almost any other. In fact with many plants from these countries it is often difficult to determine what is the typical form of the species or its original habitat. Of the Asiatic conifers, the gingko has probably been cultivated here longer than any other species, the tree on Boston Common being at least fifty years old. It has usually been considered a native of Japan, but recently this has been doubted. In a paper "On the Conifers of Japan," Dr. Masters says, in reference to the distribution of species, "Before leaving the subject of the distribution of Japanese conifers a word may be said as to the occurrence of certain trees (often of peculiar organization) in the immediate vicinity of the temples in Japan, China, Thibet, etc In some of these cases the trees are not known in a wild state, the aboriginal stocks being either extinct or lurking in some of the all but unknown districts of the Chinese empire, Thibet, or Central Asia. Among such may be mentioned as worthy the attention of students of Buddhist lore—Cupressus funebris (China, Sikkim), Abies fortunei (China), Abies kæmpferi (China), Cryptomeria japonica, Sciadopitys verticillata, Gingko biloba, and certain species of pinus. The regions thus far considered are the ones, and the only ones, from which we may add extensively to our collections. Among the regions where a few additional species may be found—in some cases very valuable ones—is

THE ROCKY MOUNTAIN REGION OF COLORADO.—Here many species of Pacific flora flourish with eastern species, and hence the region may be considered as the common meeting ground of the Atlantic and Pacific floras. From this region have come two of our most desirable ornamental trees. These are the blue Rocky Mountain spruce, and the Douglas fir. The blue spruce has been fairly tested here and proves perfectly hardy. There are several specimens in the vicinity of Boston which have reached the height of 15 feet, retaining a beautifully compact form. Individual specimens vary much in color, from a dark green to the striking glaucous blue so much admired in many specimens. This tree is known most frequently by the incorrect name of Abies menziesi, hastily given it by Colorado botanists. It should be known as Picea pungens. The Douglas fir is scarcely less beautiful, and is quite as hardy, having been tested here equally long. From an economic point of view —a side of the question which should not be lost sight of even in cultivating trees for ornament—the Douglas fir is one of the most valuable trees now existing in North America, and may in the future occupy the place likely soon to be vacated by our native pines and spruces; when, if forest culture is systematically conducted in Massachusetts, it will be a source of much profit to our people. From this Colorado region also have been introduced, with success, a hawthorn, a poplar, the white fir (Abies concolor). Pinus flexilis, Pinus ponderosa, and Picea engelmanni, the latter resembling, but distinct from, the blue spruce (Picea pungens), and not unlike our northern white spruce. There are also not often cultivated here a pine, a larch, and a spruce. The pine (Pinus contorta var., Murrayana) has withstood the winters of late at the Arnold Arboretum in good condition. The plants introduced from this region possess a remarkable interest, and establish beyond a doubt the value of experimental stations where scientific tests may be applied to tree culture. As has been suggested in a previous essay, the plants raised from the seeds of certain Colorado trees prove perfectly hardy here in New England, while those raised from the seeds of the same species of tree collected in the milder, moister climate of the Pacific slope have failed to endure our climate, but flourish perfectly in England, where most of the trees from the Pacific slope find themselves at home, thus proving by actual experiment the analogy between the climate of the Northwestern United States and that of Western Europe. Again, turning to the

EASTERN HEMISPHERE—Among regions from which we may hope to add plants for cultivation here, is a portion of Turkestan, from whence already an ash has been obtained. From Thibet, the Pinus gerardiana promises to prove hardy, and similar results may be expected from some trees in portions of the Himalaya Mountains. From the region of the Caucasus we have still more species—a maple, the Zelkowa crenata, the Pterocarya fraxinifolia, a fine specimen of which stands in the Botanic Garden at Cambridge; the Carpinus duanensis, long cultivated here, though not extensively; and among the conifers, Abies cilicica, Abies nordmanniana, and Picea orientalis. Of the last two species, specimens may be seen on some estates near Boston 15 feet high and of fine appearance. From the Balkan Mountains, of Roumelia, which is now considered its original home, though is was introduced here by way of Europe, we have the horse chestnut. This tree, in proper situations, possesses a stateliness unequaled by any other, and its magnificent show of blossoms in the month of May never fails to attract attention.

As it is said that "the exceptions prove the rule," we resort to the exceptional species from regions whence it is generally useless to attempt to introduce trees with the prospect of satisfactory results. There are certain species of trees whose geographical range is of such wide extent, that they seem to have acquired a special power to adapt themselves to different climates. Among such are the white willow and the European elm. Both of these trees are familiar objects to us, having been brought here by the early colonists as reminders of their old homes. The European elm proves, for city streets, superior to the American species, which has unfortunately been selected as the one American tree, for constant service. The American elm, although of surpassing beauty in a moist alluvial soil and with abundant space, is usually planted in a dry soil, where it does not flourish, and its drooping branches make it generally unsuitable for narrow streets, where it is frequently seen. The English elm, however, is more erect in habit, retains its foliage longer in the autumn, and withstands the smoky and dusty atmosphere of our cities far better than the American species. The European should, wherever possible, replace the American elm in our city streets. The European larch is another tree of this class. Growing naturally in a drier soil, it is much more suitable for our gravelly hills than the meager foliaged American tree, which finds its home in low, wet grounds. The Norway maple, too, in situations near the ocean, may, perhaps, be considered the most desirable among the foreign maples for general cultivation, and the conspicuous yellow blossoms coming before the leaves appear give an additional value to the tree. The Turkey oak, Fraxinus ornus, Tilia argentea, and Acer campestre may be added as desirable, and also Carpinus betulus and Salix laurifolia, and, perhaps, also Tilia dasystylis and Quercus pannonica, but the last two are not fairly tested. Among the conifers which may receive mention here is Thuja wareana, usually called Siberian arbor-vitæ, and considered a native of Europe. It is in reality a seedling variety of our own New England Thuja occidentalis. From its preference for drier soils it is much better adapted for cultivation than the typical form, which flourishes only in wet or low grounds, and is of little service in ordinary plantations. From the Pacific slope we have as exceptions the Rhamnus purshiana, well known in medicine; the vine maple, and, possibly as serviceable in favorable situations, a hawthorn, a crab apple, a poplar, Abies amabilis, Abies nobilis, and Picea sitchensis, but these need a more extended test. Among the European trees most common in cultivation is the sycamore maple, specimens of which at fifty years of age are worthless. The other European maple, the Norway, is, however, suitable for certain situations, as already stated. Neither of them is so beautiful as our sugar maples, and even the white and the red maples hold their own against them in favorable soils. The European Mountain ash, more frequently seen in cultivation than either of the American species, seldom matures, except in a miserable condition, and the European linden possesses but one advantage over our own—that of having more fragrant blossoms, while the American tree is otherwise its superior. The European ash cannot claim to even equal the American white ash either as an ornamental or as a useful tree, and neither the European beech nor the birch compares in cultivation here with the corresponding American species. Our chestnut is superior to its Old World relative, and the black walnut, or even the butternut, is far better for us than the walnut of Europe. The English oak fails here in less than fifty years, when it should be hale and hearty at a thousand. Probably no European tree has been more extensively introduced into cultivation than the Norway spruce for ornament as specimen trees, for wind-breaks, and for hedges, and yet New England possesses in the white spruce of the northern forests a tree every way its superior; or, were it possible to replace the Norway by the blue Rocky Mountain spruce, which is suited for all purposes, the improvement would be great indeed. The same comparisons may be made in favor of the American pines. The white pine far surpasses either the Austrian or the Scotch pine as an ornamental and useful tree. The red pine, which is even now found growing naturally in Massachusetts, while it resembles the Austrian pine somewhat in appearance in the young state, is just beginning its maturer life when the Austrian pine is failing, as it almost always does in the course of thirty years. The common pitch pine, often overlooked, is for us a much more valuable tree for planting in a sandy soil than either of the European species.

A very common error is to suppose that by what is known as acclimation almost any plant may be made to flourish in a climate where it does not naturally grow if it only can be inured gradually enough to the change. This theory has been proved false by actual experiments. It is not, therefore, by habituating to our climate plants from regions differing totally in climate from our own that we should expect to add to our collections, but by carefully studying the climatic conditions of all countries, and selecting from such regions as seem to possess a climate resembling ours plants which we can cultivate here with the prospect of success. We cannot, therefore, too highly estimate the value of the work contemplated by Harvard College in establishing the Arnold Arboretum. In 1874 a tract of land on the Bussey estate, in West Roxbury, near Boston, was set apart by the college for the purposes of an arboretum. A collection of living plants was at once commenced, both of native species and of those from other portions of the temperate zone. By a system of exchanges with institutions of similar character in other parts of the world, the collection was rapidly augmented, so that at the present time it contains a larger number of species and varieties of hardy trees and shrubs than any other collection in this country. It is intended as soon as practicable to plant along the roadways the species of trees and shrubs, both native and foreign, in the order of their botanical sequence, and to have them so grouped that the plants of one family will be together and readily studied. All the varieties, too, of a species will find their appropriate places in the systematic order, that the visitor may acquaint himself with their position, and readily compare them with the species from which they are supposed to have been derived. By this arrangement it will at once be seen what species and varieties are most worthy of cultivation, and in what countries or portions of countries the plants best adapted to our wants are found. Those which prove failures will also be pointed out, that we may know what to avoid in making our selections. In other portions of the grounds it is intended to illustrate the methods of making artificial forests and the different ways of planting trees for economic and ornamental purposes.

Arboriculture is indebted to horticulture for the production of many valuable garden varieties of trees. The magnificent variety of rhododendrons and azaleas, and the hybrid magnolias and other plants, attest the zeal and success of enlightened horticulturists, and by the preservation of such natural sorts as the purple beech and some of the cut-leaved birches and maples, as well as the finer sorts of weeping trees, horticulturists have contributed many valuable additions to our ornamental collections. But there is a tendency to overdo this as well as other branches of gardening, and we find the absurd practice too much in vogue of saving and perpetuating many monstrosities which should never receive a place in any collection. There are long lists of golden-leaved, cut-leaved, and blotched-leaved varieties, which are but diseased and short-lived abnormal conditions and arrested growths of healthier plants, and are wholly unworthy of preservation. Nor can much more that is favorable be said of the many so-called "inverted" varieties of hardy trees. This fashion is as unhealthy as the plants themselves, and should be as short-lived. If one-tenth the energy which is devoted to the propagation of such plants were given to the study of climate and the introduction of new species, our gardens and plantations would better illustrate the advances that modern science has made in botanical geography and the knowledge of plant life. Nor is it enough to select and secure proper trees for our plantations; it is as necessary to properly care for them as to plant them. Too little attention is paid to the proper thinning and pruning of our trees. It is a subject little understood or practiced here, although in Europe its importance has long been recognized, and pruning forms an important part of the arboriculturist's duty. The want of proper pruning and care is especially noticeable in our city and roadside trees. They are too often left to themselves, or else mutilated in rude attempts at unscientific pruning. To supply information on this important subject, the Massachusetts Society for Promoting Agriculture has recently caused to be translated from the French a treatise from the pen of the Comte des Cars, a work which has passed through many editions in France, and which is of great practical value. It should be in the hands of every one who has charge of trees, or is interested to see them properly managed. Could Mons. des Cars's directions be followed, the trees on Boston Common and in the parks and streets of our cities would present a very different appearance, and their chances for long life and greater beauty would be immensely increased. One of the most experienced and scientific horticulturists, whose name is known wherever the study of plants is pursued, has said: "It is the duty of our enlightened community to plant trees, and to so care for them that posterity shall not suffer—a duty, unfortunately, too little regarded in our day."

List of Trees which may be used for ornamental plantations in the Northern United States, arranged under the regions indicated above. Such as have not been thoroughly tested, but which may be expected to succeed, are marked by an asterisk:

I. APPALACHIAN, OR ATLANTIC AMERICAN.

Magnolia acuminata (Cucumber tree)
cordata
Fraseri
glauca (Sweet Bay)
macrophylla
Umbrella (Umbrella tree)
Liriodendron Tulipifera (Tulip tree)
Tilia americana (Basswood, Linden)
*heterophylla (Southern Linden)
Æsculus flava (Sweet Buckeye)
glabra (Ohio Buckeye)
Pavia
Acer dasycarpum (White or Silver Maple)
pennsylvanicum (Striped Maple)
rubrum (Red or Swamp Maple)
saccharinum (Sugar Maple)
" var. nigrum (Black Maple)
spicatum (Mountain Maple)
Negundo aceroides (Box Elder)
Rhus typhina (Stag's-horn Sumac)
glabra
*cotinoides
copallina
Robinia Pseudacacia (Locust)
viscosa (Clammy Locust)
Cladrastis tinctoria (Yellow-wood)
Gymnocladus canadensis (Kentucky Coffee tree)
Cercis canadensis (Red-bud)
Gleditschia triacanthos (Honey Locust, three-thorned Acacia)
Prunus americana (Canada Plum)
pennsylvanica (Bird Cherry)
serotina (Black Cherry)
Pyrus americana (American Mountain Ash)
sambucifolia
coronaria (American Crab)
angustifolia
Cratægus cordata (Washington Thorn)
Crus-galli (Cockspur Thorn)
coccinea (Scarlet-fruited Thorn)
sub-villosa (from the valley of the Mississippi)
tomentosa (Black Thorn)
Amelanchier canadensis (June-berry)
Cornus florida (Flowering Dogwood)
Nyssa multiflora (Tupelo)
Viburnum Lentago (Sheep-berry)
prunifolium (Black Haw)
Viburnum alternifolium
Oxydendrum arboreum (Sorrel tree)
Kalmia latifolia (Laurel)
Rhododendron maximum (Great Laurel)
Diospyros virginiana (Persimmon)
Halesia tetraptera (Silver-bell tree)
Fraxinus americana (White Ash)
viridis
pubescens (Red Ash)
quadrangulata (from Michigan, etc.)
sambucifolia (Black Ash)
Chionanthus virginica (Fringe tree)
Catalpa bignonioides
speciosa (Western Catalpa)
Sassafras officinale
*Ulmus alata (Winged Elm)
americana (White Elm)
fulva (Slippery Elm)
racemosa (Rock Elm, from Western States)
Celtis occidentalis (Nettle tree)
Morus rubra (Red Mulberry)
Maclura aurantiaca (Osage Orange)
Platanus occidentalis (Buttonwood)
Juglans cinerea (Butter-nut)
nigra (Black Walnut)
Carya alba (Shag-bark Hickory)
sulcata (Western Hickory)
amara (Bitter-nut Hickory)
porcina (Pig-nut Hickory)
tomentosa (White-heart Hickory)
Quercus alba (White Oak)
bicolor (Swamp White Oak)
coccinea (Scarlet Oak)
*heterophylla (from New Jersey, Delaware, etc.)
imbricaria (Shingle Oak)
macrocarpa (Over-cup Oak, Burr Oak)
Muhlenbergi (Chestnut Oak)
palustris (Pin Oak)
Phellos (Willow Oak)
Prinus (Rock Chestnut Oak)
rubra (Red Oak)
stellata (Post Oak)
tinctoria (yellow-barked Oak)
Castanea vulgaris var. americana (Chestnut)
pumila (Chinquapin)
Fagus ferruginea (Beech)
Ostrya virginica (Hop Hornbeam)
Carpinus caroliniana (blue Beech, Iron Wood)
Betula alba var. populifolia (White or Gray Birch)
lenta (Black or Sweet Birch)
lutea (Yellow Birch)
papyracea (Paper or Canoe Birch)
nigra (Red or River Birch)
Alnus incana (Speckled Alder)
serrulata (Blunt-leaved Alder)
Salix nigra (Black Willow)
cordata (Heart-leaved Willow)
lucida (Shining Willow)
Populus balsamifera
var. candicans (Balm of Gilead)
grandidentata (Large-toothed Aspen)
tremuloides (American Aspen)
Populus monilifera (Necklace Poplar)
Juniperus virginiana (Red Cedar)
Chamæcyparis sphæroides (White Cedar)
Thuja occidentalis (Arbor-vitæ)
Taxodium distichum (Bald Cypress)
Abies balsamea (Balsam Fir)
Tsuga canadensis (Hemlock)
*caroliniana (from North Carolina, etc.)
Picea alba (White Spruce)
nigra (Black Spruce)
Larix americana (American Larch)
Pinus Banksiana (Gray Pine)
resinosa (Red Pine)
pungens (Table Mountain Pine)
rigida (Pitch Pine)
Strobus (White Pine)
inops (Jersey Scrub Pine)

II. NORTH-EASTERN ASIA.

A. China and Manchuria.

Magnolia conspicua (Yulan)
stellata
(garden hybrids and vars.)
Liriodendron (species from Northern China)
Phellodendron amurense
Tamarix chinensis (Chinese Tamarisk)
*Tilia mandshurica (Manchurian Linden)
*Æsculus chinensis (Chinese Horse Chestnut
*Acer Mono
tataricum
var. Ginnala (Fragrant Maple)
Cladrastis amurensis
Gleditschia ferox (Thorny Honey Locust)
*Gymnocladus chinensis (Chinese Coffee Tree)
Cratægus orientalis
Prunus Maacii
*Mume
Cedrela chinensis
*Fraxinus mandshurica (Manchurian Ash)
*Pterocarya stenoptera
*Quercus mongolica
*Betula Ermani
*ulmifolia (Elm-leaved Birch)
Juglans mandshurica (Manchurian Walnut)
Taxodium heterophyllum (Glyptostrobus)
Pinus Bungeana (White-barked Pine)
mandshurica
Juniperus chinensis
Pseudo-Larix Kæmpheri

B. Japan.

Tilia cordata
*Acer cratægifolium (Hawthorn-leaved Maple)
*micranthum
polymorphum (including some varieties)
*Acer Sieboldianum
pictum
*truncatum
*trifidum
*diabolicum
*circumlobatum
*Acer Buergerianum
palmatum
capillipes
carpinifolium
*distylum
*argutum
*pycnanthum
*sessilifolium
*nikoense
Negundo cissifolium
Rhus semi-alata (R. Osbecki of authors)
*Phellodendron japonicum
Gleditschia japonica
Cercis chinensis (C. japonica of gardens)
Sophora japonica
Pyrus Toringo
*tomentosa
*præcox
spectabilis
Koelreuteria japonica
*Zelkowa Keaki
stipulacea
Idesia polycarpa
Rhododendron (species and garden varieties)
*Fraxinus longicuspis
*obovata
*pubinervis
*Platycarpa strobilacea
Ulmus parvifolia
Morus alba
*Pterocarya rhombifolia
Juglans Sieboldi (Japanese Walnut)
cordiformis
*Quercus glabra
*dentata
*serrata
*cuspidata
*Fagus Sieboldi
Castanea japonica
*Betula Bhojpattra
*Corylifolia
*Maximowicziana
*Carpinus japonica
*laxiflora
*erosa
*cordata
Alnus japonica
*Thuja dolabrata
*japonica
*orientalis
pendula
Cephalotaxus drupacea
Taxus cuspidata
Chamæcyparis (Retinospora)
pisifera
squarrosa
leptoclada
plumosa
filifera
obtusa
lycopodioides
pygmæa
nana
Keteleeri
breviramea
pendula
filicoides
Juniperus rigida
*nipponica
*littoralis
*davurica
Sciadopitys verticillata (Umbrella pine)
Pinus densiflora (often cultivated as P. Massoniana)
*Thunbergi
Pinus parviflora
koraiensis
Tsuga japonica (Japanese Hemlock)
Gingko biloba (Gingko tree, Salisburia)
Larix læptolepis

III. SPECIAL REGIONS.

A. Rocky Mountain region of Colorado.

Acer glabrum
*Robinia Neo-Mexicana
*Cratægus rivularis
Betula occidentalis
*Populus angustifolia (narrow-leaved Poplar)
Abies concolor (White Fir)
*subalpina
Pseudotsuga Douglasi (Douglas Fir)
Picea Engelmanni
pungens (Blue Spruce)
Pinus ponderosa var. scopulorum

B. Siberia.

Caragana arborescens
Halimodendron argenteum
Ulmus pumila
Picea obovata

C. Turkestan.

Fraxinus potimophila

D. Thibet.

*Pinus Gerardiana

E. Caucasus.

Acer lætum
Zelkowa crenata
Pterocarya fraxinifolia
Carpinus duanensis
Picea orientalis
Abies Nordmanniana
cilicica

IV. EXCEPTIONAL SPECIES.

A. Pacific Slope.

Species of the Pacific forest of more or less wide geographical range, which should be tested in New England, from their more northern limits in the Rocky Mountains and coast ranges.

Rhamnus Purshiana
Acer circinnatum
*macrophyllum
*Cratægus Douglasi
*Pyrus rivularis
Fraxinus oregana
*Quercus Garryana
*Populus tricocarpa
*Alnus rubra
*rhombifolia
*Salix lasiandra
*Torreya taxifolia
*Chamæcyparis nutkaensis
*Thujopsis borealis (of gardens. Hardy in New York)
*Thuja gigantea
*Abies nobilis
*grandis
*amabilis
*Tsuga Mertensiana
*Pattoniana
*Picea sitchensis
*Larix Lyalli
*occidentalis
*Pinus albicaulis
*contorta var. Murrayana (Twisted Pine)
flexilis
*Pinus Lambertiana
*monticola

B. European.

Æsculus Hippocastanum (Horse Chestnut)
Acer campestre
platanoides (near the ocean)
Tilia argentea (Silver-leaved Linden)
dasystylis
Fraxinus ornus
Ulmus montana
campestris
Quercus Cerris (Turkey Oak)
pannonica
Carpinus Betulus
Salix alba (White Willow)
laurifolia
Populus alba (White Poplar)
*Picea Omorika
Larix europea (European Larch)

DISCUSSION.

Mr. C. M. Hovey thought there was something in taking seed from trees growing in northern regions. He had never seen a tree of Abies douglasi 10 feet high in this country except at Mr. Hunnewell's. Prof. Robinson said he knew of trees of the Douglas fir raised from Colorado seed 12 feet high, and that this species forms an admirable illustration of the rule that trees raised from seed collected on the Pacific slope are tender, while those of the same species from Colorado seed are hardy here. All the California trees raised in England forty years ago were from seed collected on the Pacific slope. Mr. Hovey said that Mr Hunnewell imported trees of Cedrus deodara, which, though they proved tender, grew large enough to produce seed, and the trees raised from this seed proved hardy. He said that he admired the English elm, but objected to it as a street tree. The limbs grow out horizontally, and those on the Beacon Street Mall stretch almost across the street. He had read of elm trees in England which were dangerous from this cause. The American elm, on the contrary, grows more erect, does not give too much shade, and the limbs will not interfere with travel. The English elm holds its leaves longer than the American, which is an advantage. The sugar maple is a fine tree of slow growth; it takes about thirty years to get it 30 feet high, and our people are unwilling to wait for it. The same may be said of the scarlet maple. The white or silver maple is of more rapid growth, and a very fine tree. Its greatest fault is that the branches are liable to be broken by gales, but the broken limbs may be cut off without material injury. The oriental spruce and Nordmann's spruce are two of the finest. He had raised seedlings of the Salisburia, or Gingko tree, which averaged one foot of growth in a year. He thought the Gingko tree on Boston Common was older than stated by Professor Robinson—probably eighty or ninety years old. The Liquid-ambar, whose foliage is so beautiful in autumn, is tender here.

Mr. W. C. Strong asked, in reference to the greater hardiness of trees of Picea pungens and other species when grown from Colorado seed as compared with those raised from seed from the Pacific slope, whether it was not the process of acclimation continued over a long period which made the difference?

The Hon. Marshall P. Wilder could not agree with Mr. Strong in regard to acclimation, but thought it in a general sense a fallacy. Soil and situation have a great deal to do with hardiness. He has a Cedar of Lebanon on a ledge where there is but six inches of soil; and neither too much nor too little water, which has survived when every other one in New England (so far as he knew) had been destroyed.

Professor Robinson said that we must draw the line between what can be accomplished by a man in a single generation and what can be done by nature in the course of ages. The changes effected by nature are gradual and imperceptible. The introduction of hardy and tender forms of the same tree from Colorado and California is very different from acclimation. Both forms were probably disseminated from one stock at the close of the last geological epoch, when they were forced north, some to Colorado and some of California—perhaps a million of years ago—and during that time, which cannot be computed, have gradually acquired the differences which now mark them.

CULTIVATION OF FLAX IN NEW ZEALAND.

CONSUL GRIFFIN states that *Phormium tenax* is by far the most valuable fibrous plant indigenous to New Zealand, and since 1809, it has been an article of export. The attention of Europeans was first directed to it by Captain Cook, who described it as something superior to either flax or hemp. The Maories have for many years used it for binding together the frame-work of their houses, and for making clothing, baskets, fine mats, fishing nets and lines, and sails for their boats and canoes. *Phormium tenax* is sometimes called the flax lily. The leaf varies in size from three to fourteen feet in length, and from half an inch to five inches in breadth at the widest part. It grows in bunches or groups of plants; each shoot has five leaves, and, on an average, about ten of these shoots form a bunch. The leaves are perennial, hard and sword-shaped, with a stalk rising five or six feet above them, bearing a profusion of yellow, and sometimes red flowers, followed by triangular pods filled with flat and thin black shining seed. The plant attains its full growth in three years, when the leaves generally split at the end, and it first comes into flower. It is said that in rich soil the flower rises to a height of twenty feet. The leaves are smaller than those of European flax and hemp plants, being composed of cellular trusses running the whole length of the leaf incased in a green substance. The trusses consist of two parts, wood and bast, the latter forming the fiber so highly prized. The vascular bundles compose the inner bark of the plant, and serve to circulate the juices which are taken from the soil by the roots; these consist of exceedingly fine threads, one overlapping the other in such a manner as to give a free circulation throughout the leaf. The plant is indigenous to New Zealand and Norfolk Island, although it has been transplanted in India and other countries. It grows best in rich, moist, and well-drained grounds, and attains its maximum growth on the banks of running streams. When the leaves are full grown the natives gather them when green, and separate the fibers; they scrape the leaves with a shell, and then

divide them with a comb. They are then put in the sun to dry, and when dry are perfectly white, soft and silky to the touch. It takes only a very short time to prepare the fiber, and about one ton of fiber is produced by the natives out of four and a half tons of green leaves. A full grown plant will produce on an average about thirty-six leaves, besides shoots from the roots, and it takes about six leaves to yield one ounce of fiber. At this estimate an acre of ground planted three feet apart would yield about sixteen hundredweight of fiber. There are very many varieties of the *Phormium tenax*, among them being the *aonga*, a variegated flax; *atewhiki*, a very white fiber, used for making fine mats and garments, the leaf is narrow with a reddish tinge and bright scarlet lines; *sapoto*, cultivated at Coromandel, Kawhia, and Waikata, glossy leaves rather red at the edge, having a general orange green appearance; *sarariki*, a species of very fine and soft texture used for making ornamental mats, the leaves tapering, of a dull olive green. There are several flax mills in New Zealand, principally in Auckland, used chiefly for dressing the flax for rope making. Here the green leaves are stripped by revolving rollers with projecting beaters traveling at a high rate of speed, these crush the epidermis against a fixed plate so arranged as to allow room for the fiber to remain intact. The fiber thus freed from the leaf of the plant is washed by various methods, put on the ground or on lines to dry and bleach, finished by an arm or barrel scutch, and when boiled is ready for market. All the machines used are identical in principle, and vary only in the details by which the principle is carried out. This principle is that the leaf is held between horizontal feed rollers, revolving at a certain speed, while as the leaf passes out from them, a drum, armed in its circumference with iron beaters, and revolving more rapidly than the feed rollers, strips the epidermis and tissues away from the fiber, means being provided for adjusting the beating drum to a proper distance from the roller or bar against which the phormium leaf is stripped, so that the leaf may neither, on the one hand, pass through without being crushed, nor, on the other, have the fibers cut. The method of preparing fiber by machinery is a great improvement over that pursued by the Maoris, as regards the quantity produced, as they do not obtain from each leaf one-fourth of the quantity which is obtained in machine dressing. The natives cut off the leaves about six inches below the point where the two blades adhere together, and reject the colored edges; they also take much time and pains in preparing the leaf, often soaking it for four or five days in running water, and then beat it with a stone or mallet. This process is repeated over and over again for four or five weeks. Consul Griffin states, however, that the fiber dressed by the natives is far more valuable and beautiful than that prepared by machinery. The principal competing fiber with *Phormium tenax* is Manila hemp. This is made from a species of plantain, called *Musa textilis*, which is planted generally on the slopes of hills, and requires shade and plenty of moisture. The trees are planted about eight feet apart, and are cut down at the end of the third year, and made into fiber. A full-grown tree is estimated to yield about one pound and a half of hemp. The process of manufacture is as follows: The tree is cut down and stripped of its linings; these are then cut into pieces three or four inches wide, after which they are drawn underneath an instrument resembling a saw fixed in a block of wood. The fleshy part of the cortex is scraped off, and the fiber alone remains, which is then placed in the sun to dry. Two persons, one engaged in cutting down the trees and stripping them, and the other in extracting the fiber, can work up about 25 pounds of hemp in one day. The value of *Phormium tenax* exported from New Zealand, in the year 1880, amounted to £16,267.

INJECTIONS OF THE VIRUS OF HYDROPHOBIA INTO THE CIRCULATION DO NOT PRODUCE RABIES AND SEEM TO CONFER IMMUNITY FROM THE DISEASE.

Translated from the French by GEO. M. STERNBERG, Surgeon U. S. A.*

[*Note by translator.*—Not having seen in the medical journals any reference to the following important and interesting communication to the French Academy, I have thought it worth while to translate it without abridgment for the benefit of the readers of the *Medical Record*.]

Since I have undertaken to study hydrophobia I have had occasion a number of times to inject the virus of rabies into the jugular vein of the sheep, and I have never seen the disease appear as the result of such injections. Moreover, animals which have been inoculated in this manner, having been subsequently utilized for other experiments and having been inoculated with the virus of rabies in other ways, have not contracted hydrophobia. The following are the principal facts which I find recorded in my record of experiments:

Experiment No. 1.—May 4, 1879.—Inoculated two sheep, one in the jugular vein, and one in the subcutaneous connective tissue; the last became rabid on the 10th of June, and died two days after; the other resisted and was again inoculated by a different method on the 9th of October and on the 23d of December, without result. This sheep was utilized for other researches March 11, 1880.

Experiment No. 2.—October 9, 1879.—Three sheep were inoculated with the virus of rabies, *two by punctures* and scarifications and one by *intravenous injection;* the two first died of hydrophobia on the 26th of October and the 7th of November. The other was reinoculated by punctures and scarification March 26, July 8, and December 19, 1880, without having contracted the disease.

Experiment No. 3.—December 19, 1879.—Two sheep were inoculated with the saliva of rabies, one by hypodermic injection, the other by *intravenous injection*. The first died of rabies, January 24, 1880; the other, in good health on the 24th of February, was reinoculated by different methods on three different occasions without result up to the time it was employed for other researches, December 9, 1880, two months after the last inoculation.

Experiment No. 4.—December 31, 1879.—Two rabbits were inoculated by punctures, and two sheep by *intravenous injection*. The two rabbits died of hydrophobia, January 17 and 22, 1880. The two sheep were reinoculated by scarification, March 20, May 14, and July 18, 1880, but still remained in perfect health on the 9th of December of the same year.

Experiment No. 5.—April 19, 1880.—Two rabbits were inoculated by punctures, and one sheep by *intravenous injection*. The two rabbits died of hydrophobia, April 30 and May 9. The sheep was reinoculated by punctures and hypodermic injection June 24 and October 17. This animal was utilized for other researches, January 25, 1881.

Experiment No. 6.—February 3, 1881.—Two sheep inoculated with virus of rabies, one by hypodermic injection, the other by *intravenous injection*. The first died of hydrophobia March 2, the other resisted and was reinoculated by punctures and scarification March 13 and 17. It remained in good health July 28.

Experiment No. 7.—March 13, 1881.—One goat and three sheep were inoculated. One of the sheep, inoculated by punctures, died of rabies, April 22. The two other sheep and the goat, inoculated by *intravenous injection*, were reinoculated by scarification March 27 and July 28, without result.

Experiment No. 8.—February 19, 1881.—Five rabbits received, as a drink, a mixture of water and saliva of rabies. Three resisted and two died of hydrophobia, March 2, and March 9.

The following conclusions are drawn from these facts:

First.—Injections of the virus of rabies into the veins of the sheep do not induce rabies, and seem to confer an immunity against it.

Second.—Rabies may be transmitted by injection of the virus, although the locality where the inoculation takes place in this case has not yet been determined. It is, nevertheless, demonstrated that there is danger of contracting the malady by the introduction of the virus into the alimentary canal.

I propose to verify the fact of immunity as the result of intravenous injections by experiments upon *the dog*, and I am endeavoring to ascertain if intravenous injection of the virus *practiced a day or two after a bite, or an inoculation with virus, can preserve an animal from rabies.*

* Communication to the French Academy of Sciences by M. V. Galtier, presented by M. Bouley (C. R. Ac. des Sci., t. xciii., pp. 284-5).—*Medical Record.*

CEREAL FOODS.

To the Editor of the Scientific American:

In the publication of an article headed "Cereal Foods Under the Microscope," by Ephraim Cutter, M.D., in your issue of SCIENTIFIC AMERICAN SUPPLEMENT, April 15, 1882, purporting to give reliable information regarding the use of infant foods by physicians through microscopical tests, as manufacturers of infant and invalids' food that has been in use for years, and in which the greatest care has been exercised to produce a food that should be in all respects satisfying and nutritious, suited as far as possible to all conditions of age and constituton, we can but regard the article as pernicious in its influence.

While we have no disposition to speak disparagingly of other foods, several of which we regard as having their own peculiar claims for merit, or to the methods taken by them to obtain notice from physicians, yet we do decidedly object to statements made which have no foundation in fact, and the use of your journal in the publication of an article so damaging in its influence without protest against such unfair use of your editorial columns.

The physician who is progressive or enough so to take several medical journals is already cognizant of the difference of opinion entertained; and the corrections by wiser heads of these misstatements, notably the letter of Professor Jos. G. Richardson, of University of Pennsylvania, dated June 16, and for these reasons we deem the time has arrived when not because we write as manufacturers, but in the interest of medical knowledge, you should make public this letter.

Palmer, Mass. WOOHICK & Co.

ETHER SPRAY FOR NEURALGIA.

IN the spring of 1869 we had the most severe attack of facial neuralgia which it has been our lot to witness in more than eighteen years of practice; for two weeks we had to confine ourselves to a darkened chamber, and the lightest footfall on the floor caused us the most excruciating agony. All the remedies, local, general, regular, and irregular, were tried without any abatement of the trouble. One side of our face was terribly swollen, so much so that it was impossible to extract a decayed molar, to which we charged all our suffering, and it seemed as if we were destined to shuffle off this mortal coil by exhaustion from pain and want of sleep. We finally concluded to incise the swollen jaw, thinking there was an abscess about the root of the decayed tooth, and as the parts were so extremely sensitive, and, moreover, having a vague dread of chloroform, we thought we would try local anæsthesia by evaporating ether on the surface until the part was frozen. Our attendant complied with our instruction, and the spray was turned on. The first sensation was one of cutting pain, gradually subsiding, until, when congelation took place, we felt perfectly easy, and ordered the cutting operation deferred. Then for fifteen hours we slept the sleep of the righteous, and when we awoke found the *rubor et tumor, calore, cum dolore* entirely vanished, and we arose and went about our business; and to this good day, although we carry a perfect cabinet of curious teeth in our mouth, have never had a neuralgic twinge or touch of that "hell o' a disease," a toothache. Well, to be honest about it, we did not at the time give the freezing process any credit for the cure; we thought the attack had about spent its force and was going to act well anyway, and we paid but little attention to the matter for a year or more, when a relative, Capt. Harris, was visiting us, and took a spell of neuralgia, which he had for over a year been periodically afflicted with, rarely passing a month without an attack. To give him present ease, for we did not think of any permanent benefit, we tried the spray all along the track of the affected nerve, and until it turned the skin white. The relief was immediate, and, he has since informed me, permanent.

Since then we have used it in fifteen or twenty cases with uniform success, never having to make more than two applications, and it came to be a stock remedy, and we thought that, in all probability, was so with most physicians; for we remember that when Richardson first introduced it (like all new things in medicine, it was vaunted for everything), and would probably have still thought so if a gentleman hadn't called on us some time ago to know if we hadn't a new treatment for neuralgia, and stated that a couple of years ago he was on a steamboat and was suffering with that disease when Capt. Harris informed him that he was cured by some sort of a freezing process, and advised him to try it. When the boat reached Louisville he called on two or three dentists and three of the most distinguished surgeons of the city, and they told him they knew of no such remedy for neuralgia, and advised him not to have anything of the kind done. On hearing his story we looked over old medical journals, and found not a single allusion to local anæsthesia as a remedy for neuralgia.

Now we must confess that all this sounds very much like the story of the superannuated clergyman who accidentally, while in the West Indies, discovered a cure for consumption, only we don't want any one to send a stamp for particulars. Any physician can purchase a hand-ball atomizer for $1.50, and try it. They may use either rhigolene or ether, and it will only be necessary to let the spray play upon the part until the skin turns white. We promised to offer no theory for its action, but we will venture this opinion: That the intense cold, by the revulsive effect, causes a complete change in the nutrition of the nerve; what this change is we will not at present venture to assert, only hoping that others who have better opportunities will give the matter a trial and fully test it.—*Dr. McColganan, in the Southern Practitioner.*

LUMINOUS AND NON-LUMINOUS GAS FLAMES.

By G. ERNEST STEVENSON.

THE principles upon which the action of the flame of an ordinary gas-burner is based are well known, and the theory by which the illumination is explained is rarely called in question. The gas contains a certain amount of carbon in chemical union with hydrogen. The combustion of the gas at the orifice of the burner creates an amount of heat sufficient to decompose the hydrocarbons; the carbon is set free in a finely divided state, and becoming incandescent by the heat of the combustion, produces the illumination with which we are so familiar. Certain conditions are necessary to produce these illuminating results to the best advantage. The flame must be of such a form as to bring every particle of the issuing stream of gas into intimate contact with the atmospheric air, so that the combustion may be rapid and complete; and when, as in the case of the Argand burner, this cannot be done naturally, a current of air must be artificially directed on to the burning gas. This combustion, however, may be made too rapid, in which case a loss of illuminating power will be the result. An Argand burner does not yield the full value in light from the gas consumed when turned down, because too much air is then passing up the chimney. With the Siemens burner also the quantity of air supply requires to be reduced after the burner has been properly heated up, otherwise the jets of flame become short, and fail to give the full lighting effect. It is therefore possible to create a too rapid combustion; in which case the carbon particles have not sufficient time to attain their maximum degree of incandescence before being recombined in the form of carbonic acid. On the other hand, an imperfect combustion, while setting free the carbon, fails to heat part of it to incandescence, and in consequence the carbon neither illuminates nor combines with the oxygen of the atmosphere, but ascends in the form of smoke to pollute the air and blacken the ceiling.

While the theory of illuminating gas flames is thoroughly established, that of the atmospheric or Bunsen burner has not been left undisputed. Experiments have been made which go to prove that by the application of more heat the flame of the Bunsen burner regains its luminosity, and doubt has been thrown on the generally accepted theory that the character of the flame is due to internal oxidation; and it has been affirmed that the loss of illumination is due to the cooling effect produced by diluting the gas with atmospheric air.

In the year 1875 a certain chemist named Wibel published the results of some experiments he had performed upon coal gas mixed with nitrogen, carbonic acid, and steam. He found that the flame thus rendered non-luminous regained its luminosity when the tube from which the gas issued was heated to redness. He also stated that the same phenomenon might be observed with the ordinary Bunsen burner, in which gas is mixed with atmospheric air, if a platinum tube was inserted in the mouth of the burner, and heated to incandescence. This experiment has since been frequently performed to show that a non-luminous flame may be rendered illuminating by simply increasing the temperature at which the combustion takes place. In the same year the conclusiveness of Wibel's experiment was questioned by Herr Heumann, who proposed the following questions which it was necessary should be negatived before the conclusion arrived at by Wibel could be definitely accepted, viz.: (1.) Does any change occur in the proportions of air and of gas in carrying out the experiment? (2.) Is the chemical constitution of the mixture altered in passing through the glowing tube? Heumann, however, did not attempt to solve these questions, but contented himself with altering the form of the experiment, so as to prevent the possibility of a change in the quantity of air mixed with the gas. He mixed the gas and air together in a gasholder, and passed the mixture through a platinum tube 10 centimeters in length and 8 millimeters in diameter. When cold the mixture burned with a blue flame, and when the tube was heated it became luminous, returning, however, to its original appearance on the tube being allowed to cool. In answer to the second question, Heumann proposed to test whether the gas, after having been passed through the heated tube and afterwards cooled, would burn with a luminous flame or otherwise. To do this he caused the gas to pass from the platinum tube through a glass tube immersed in cold water, and on lighting it as it issued from the tube be found that it burned with a blue flame. From this he concluded the correctness of Wibel's experiments.

In 1881, R. Blochmann published in Liebig's *Annalen* (vol. ccvii., p. 267), a series of experiments which gave results diametrically opposed to the conclusions of Heumann, and showed that the true answer to both the questions propounded by him was in the affirmative. Blochmann regarded the experiments of Heumann as not more conclusive than those of Wibel. He set himself to solve the questions proposed by Heumann, and determined to analyze the gaseous mixtures before and after passing them through the heated platinum tube. To effect this he introduced into the side of a Bunsen burner a tube of small dimensions, and abstracted a portion of the gas by means of an aspirator. From these analyses he discovered that the effect of heating the tube was to reduce the velocity with which the gas issued from the burner, and thereby to diminish the proportion of air mixed with the gas. To completely destroy the luminosity of the gas, a mixture containing 61·30 per cent. of air and 38·70 per cent. of gas was found necessary; but with an ordinary Bunsen burner the retardation of velocity due to expansion, that ensued on heating the tube, altered these proportions to 30·06 per cent. of air and 69·94 per cent. of gas. So that, from containing, under ordinary conditions, nearly two volumes of air to one of gas, the mixture became altered so as to contain less than one volume of air to two of gas. A similar test made with the Bunsen burner alone, without the heated platinum tube, showed that when the burner was lighted 5·6 per cent. less air mixed with the gas than when the gas was allowed to escape unignited. The

proportions of air and gas are therefore greatly affected by the influence of heat at the outlet of the burner.

In regard to the question whether a change in the chemical constitution of the gases occurs in passing through the heated platinum tube, Blochmann's experiments showed that combustion takes place within the heated tube to the extent of the oxygen present in the mixture. He first analyzed the gas, which he found to possess the following constitution:

Hydrogen	52·75	per cent.
Carbureted hydrogen	35·28	"
Olefiant gas	2·01	"
Propylene	0·72	"
Benzole vapor	0·66	"
Carbonic oxide	4·00	"
Carbonic acid	1·40	"
Nitrogen	3·18	"
	100·00	

He then mixed the gas and air in a gasholder in the required proportions, which mixture burned with a blue flame, having a slightly luminous point. To prevent any change by diffusion, the platinum tube was inclosed in one of hard glass, and the two heated together. In passing the gas through the heated tube, no deposit of carbon or tar was observed; but water accumulated in considerable quantity in the condensing bends attached to the tubes. An analysis of the gases after passing the heated tubes, gave the following results:

Hydrogen	0·84	per cent.
Carbureted hydrogen	18·41	"
Olefiant gas	0·44	"
Propylene	0·46	"
Benzole vapor	0·28	"
Carbonic oxide	4·58	"
Carbonic acid	2·01	"
Nitrogen	72·98	"
	100·00	

Worked out to show the percentage of each constituent before and after the experiment, on the basis of the original volume, the following statements show the change which had taken place:

Mixture of Air and Gas before Experiment.

38·7 per cent. gas	H = 20·41		
	CH_4 = 13·65		
	C_2H_4 = 0·78		
	C_3H_6 = 0·29		
	C_4H_8 = 0·25		
	CO = 1·55		
	CO_2 = 0·54		
	N = 1·23	49·68	
61·3 per cent. air	N = 48·45		
	O = 12·85		
100·0		100·00	

Mixture of Gases after Experiment.

H	= 0·57	
CH_4	= 12·54	
C_2H_4	= 0·30	17·03 per cent. combustible gases.
C_3H_6	= 0·31	
C_4H_8	= 0·19	
CO	= 3·12	
CO_2	= 1·37	
N	= 49·68	73·52 per cent. inert gases.
H_2O	= 22·47	
	90·55	
Loss by contraction	9·45	
	100·00	

From this it will be seen that a combustion takes place within the heated tube at the expense of the oxygen present in the mixture. Chiefly it is the hydrogen that is consumed, a small proportion only of the hydrocarbons undergoing decomposition, with the resultant production of carbonic oxide and carbonic acid. After being cooled, the gases burned with a perfectly blue flame.

From the analyses made by Blochmann, it is clear that the blue flame exhibited by the gases after passing through the heated platinum tube is not synonymous with the blue flame of the Bunsen burner. These partially burnt gases assume a constitution analogous to that of the mixture used by Wibel in his first experiments, produced by mixing coal gas with nitrogen, carbonic acid, and steam—the so-called Knapp flame for low temperature. The experiment which Wibel performed with the Bunsen burner really falls into the same category as those carried out with coal gas thus altered by the admixture of the above inert gases, because, by passing the gas and air through the heated platinum tube and before ignition, the mixture lost the characteristics of the Bunsen burner, and became transformed into one similar to that of the Knapp gas, and therefore the appearance of the mixture in combustion could not have any bearing upon the non-luminous character of the Bunsen flame. Wibel concluded that both the Knapp flame and the Bunsen flame were non-luminous because of the cooling effect of the inert gases present in the mixture. This is correct as applied to the former; but as regards the Bunsen burner it is well known that the temperature of the flame is far higher than that of an ordinary illuminating burner. In the experiment of passing the mixture of gas and air from a Bunsen burner through a heated platinum tube, the mixture becomes converted into one possessing a similar constitution to the Knapp gas. If this mixture be ignited while still hot, as it issues from the tube, it will burn with a luminous flame, but unlike that of illuminating gas; rather will it appear like the flame of a spirit lamp in which soda has been sprinkled. If, however, allowed to cool first, it will, in common with the Knapp mixture, burn with a non-luminous flame, having too low a temperature to decompose the hydrocarbons present.

The non-luminosity of the Bunsen flame is due to a totally different cause. In it the oxygen present produces combustion in the interior of the flame. The presence of the oxygen in a state of intimate contact with the particles of gas, and the product of a more intense heat than can exist in the flame of an ordinary burner, produce a sudden transformation in the constitution of the gases, so that the hydrocarbons disappear, and their carbon particles become re-combined in too short a space of time to permit of their becoming incandescent. While in the ordinary gas flame the combustion of the carbon takes place in the outer zone of the flame, with the Bunsen burner not more than 6 per cent. of the combustible constituents ever reach the outer portion of the flame, and come in contact with the oxygen of the outside atmosphere.

As in Wibel's experiment the proportion of air must have been diminished (by the action of the heated platinum tube) to about one-half that of the gas, it follows that the product must be luminous to some extent, for a mixture of 1·45 volumes of nitrogen is necessary to deprive 1 volume of coal gas of its luminosity. When, however, as in Blochmann's experiment, the gas and air are previously mixed, so that no alteration in the proportions can take place, only 20 per cent. of combustible gases remained in the mixture after passing the heated platinum tube; under which conditions no luminosity could possibly be observed, notwithstanding the application of the strongest heat.—*Journal of Gas Lighting.*

MULE'S MILK.*

By Professor ALFRED DUGES.

ALTHOUGH observations relative to the milk given by animals which have not passed through the state of gestation are few, still a number have been recorded, including some regarding the human species. Frèmy has given an analysis of the milk of a sheep and Schlossberger of that of a goat. Facts of this nature being so uncommon, I believe that the note which, conjointly with my learned friend, Professor Vicente Fernandez, I now publish, will prove of considerable interest.

On the 11th of May, 1876, having learned that there was a mule in milk at the Hacienda d'Argent de San Pedro de Rocha, on the Marfil road, a quarter league from Guanajuato, I went to the place, accompanied by my friend Fernandez. Through the kindness of the employés of Mr. Bernardo Lopez, proprietor of the farm, we were permitted to examine the phenomenal animal, which was then working in an ore mill.

The mule is of a chestnut color, with the nose, lower parts of the limbs, belly, tail, and mane white. Its height is about 1½ meters; its proportions are perfect, without fullness of the abdomen; the breast is also larger than those of hybrids of the same kind ordinarily; the back is quite concave. Except in these particulars, however, there is not the least doubt but that we had before our eyes an ordinary mule. We were told that it had been bought five years before, and, according to the workmen, it was at least seven years old. On examination, however, I discovered that the teeth resembled those of a horse four and a half or five years old. It is possible that there is an anomaly here co ordinate with the peculiar appearance presented by the mammæ. The latter are shaped like the alligator pear (*Persea gratissima*), black, and without nipples. Their length is 12 centimeters, exclusive of the base, which is buried, as it were, in the skin of the abdomen; as a whole, the organs somewhat resemble testicles. According to the information given us, the animal had never given birth to offspring, nor had ever been served by an ass or horse. It appeared that two years before a workman in the establishment, seeing that the mammæ were a little large, attempted to milk the animal, and that the repetition of this act had brought about the condition in which we found the animal. In a moment, and before us, more than four hundred grammes of milk were drawn, which issued with much force and fell foaming into the vessel prepared to receive it. When it had remained undisturbed for a little time it appeared of a dead white color, resembling that of milk of almonds. Its odor was slight, not at all resembling that of the mule. Its taste seemed to me oily and a little sweet, but as I tasted of it with repugnance I cannot describe the flavor accurately. Regarding its other peculiarities I refer to the note of my friend, Professor Fernandez. The microscopic characters were those of ordinary milk.

Such are the more important facts which I learned regarding the hybrid in question. The matter is known to a large number of the citizens of Guanajuato.

The following note on the nature of the mule's milk is extracted from the report of Prof. Vicente Fernandez, which appeared in the same number of the "Repertorio" in which my own observations were first printed:

"The liquid obtained from the mule has the appearance of whey, is without sensible odor, and has a sweet taste. Its reaction is slightly alkaline. Density, 1.0270. Heat alone does not coagulate it. Acetic and hydrochloric acid coagulate it, however, and leave oil globules upon the filter. Sulphuric acid coagulates the milk also, and gives a white precipitate by forming an insoluble compound with the casein. It contains, therefore, two of the principal constituents of cow's milk—fats and casein.

"By pouring into a test-tube 80 drops of pure sulphuric acid, 5 centigrammes of ox-besoar,† and a drop of milk, and heating to 60° or 80° F., I obtained a reddish purple color similar to that of a solution of permanganate of potash. This demonstrates the presence of glucose, which is formed by the sulphuric acid at the expense of the lactose—another principle of cow's milk.

"In order to prove the existence of butter and of casein, I mixed 20 centiliters of milk with an equal volume of a saturated solution of sulphate of soda and one gramme of carbonate of soda.

"Filtration gave a clear liquid, and butter remained on the filter. The liquid, neutralized by acetic acid, gave a precipitate of casein, which the carbonate held in solution.

"A quantitative analysis gave the following figures, the process being carried on with the greatest care:

	Liter.	Hundredths.
Water	908·50	90·850
Casein	19·45	1·945
Butter	17·00	1·700
Sugar of milk	51·30	5·130
Fixed salts	3·75	0·375
	1,000·00	100·000

"The result proves that the liquid in question is a true milk, and that this milk does not differ from that of horses in general, except by the presence of a little more fat, which diminishes its density. Possibly the predominance of fat is due to the fact that the milk remained a long time in the mammæ, and that the casein underwent a regressive change. Otherwise it is a liquid almost entirely composed of olein."

Subsequent to the time of this observation my friend, Mr. Epifanio Jimenez, brought to Guanajuato a mule five years old, which gave about a liter of milk daily for four months. The animal was taken away again, however, so that I was unable to examine it.

I have been made aware of an additional fact. I received milk from two mules of the Hacienda de Luna, near Guanajuato, in February, 1880. It is salt, very fat, and whiter than that of which an analysis has been given. The facts which I obtained are as follows: One mule is fifteen years old, the other eighteen. The first furnishes milk at all times of the year, and has done so from the time it was purchased. The second mule has been under observation only a month. Neither has given birth to young. The quantity of liquid given by the first animal is 250 grammes per day; by the second a liter or a liter and a quarter.

*Translated by Frederick W. True, from Professor Duges's French version of his original Spanish.

Translation of a note contained in "El Repertorio" of Guanajuato, Mex., No. XVII., 1876. From Proceedings of United States National Museum.

† This reagent, very delicate for use in recognizing the presence of glucose, is a discovery of Vicente Fernandez, and has always been of great service to me in testing diabetic urine.—A. D.

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